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CHAPTER 1

EDUCATION, THEN AND NOW

Meaning of Education

The imperative character of education for individual growth and social development is now accepted by every one. Investment in the education of its youth is considered as most vital by all modern nations. Such an investment understandably acquires top priority in developing countries. Education, in one sense or another, appears to be as old as the human race, though in course of time, its meaning and objectives have inevitably undergone certain changes. The root meaning of education is given as *bringing up* or *leading out* or *making manifest* the inherent potentialities in a pupil. Broadly speaking, education refers to any act or experience that has a formative effect on the personality of an individual. Such a view of education will include all of life's experiences. In a technical sense, however education refers to the process by which society, through its different institutions, deliberately transmits its cultural heritage to its young—its accumulated values, knowledge and skills from one generation to another.

Education is often regarded as synonymous with learning, as the acquired experience of any sort—intellectual, emotional or sensory-motor. Education is a product of experience. It is the process by which and through which the experience of the race, i.e., knowledge, skills and attitudes are transmitted to the members of the community. John Dewey speaks of "education as that reconstruction or reorganisation of experience which adds to the meaning of experience and which increases ability to direct the course of subsequent experiences." Education proceeds from birth to death and the school is not the only agency that imparts education. Though the school exerts greater influence in educating the child, other social agencies like home, religion, press, radio, library, cinema, television, etc., supplement its work. Life involves a constant and continuous modification of experience. Ideas change, attitudes and skills undergo alteration.

Introduction To Educational Technology

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INTRODUCTION TO
EDUCATIONAL TECHNOLOGY

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EDUCATIONAL TECHNOLOGY

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Education is the process of helping the child to adjust to this changing world. Such an adjustment is not a 'somehow' one but a *superior adjustment*. The best type of education is that which guides the immature child to live his life richly and abundantly, at the same time to contribute to social betterment. The aim of education has varied from race to race and generation to generation but the main point of emphasis has always been on the mental and physical growth of the individual. The methods employed at various ages may also be different but the basic factor remains the same. The child is subjected to certain experiences that are intended to modify his behaviour for proper adjustment.

Educational adjustment of the child is conditioned by the nature and demands of society to which the child should get adapted and attuned; so what could pass for superior adjustment a few centuries ago will be valueless in the society of today. The most distinctive feature of modern society is its science-based technology. It is this which has helped modern societies to increase their production spectacularly. Science-based technology has other important implications for social and cultural life. The changes that occur as a result of its impact are broadly described as *modernisation*. This modernisation affects the educational system also. There has been a great explosion of knowledge during the last few decades. In a traditional society, the stock of knowledge was limited and grew slowly. The main aim of education was interpreted to be the preservation of this accumulated treasure. But in modern society, knowledge in every subject is cumulative so that as each year passes, there is more to be learnt. One of the main tasks of education in a modern society is to keep pace with this advance in knowledge. In such a society, knowledge cannot be received passively. It is something that is to be actively discovered. The main aim of education should be on the awakening of curiosity, the stimulation of creativity, the development of proper interests, attitudes and values and the building of essential skills such as independent study and capacity to think and judge for oneself. The Indian Education Commission (1964-66) observes that education must serve as a 'powerful instrument of social, economic and cultural transformation necessary for the realisation of the national goals'. Along with the knowledge explosion that is found in developed countries, we see another factor namely population explosion, particularly in developing countries, that is trying to change the pattern of life. Most countries in the world are faced, in some form or another, with these problems and what is needed today is an "education explosion". Curing illiteracy is the immediate problem in developing countries. It has been estimated that half of the world's population is totally illiterate and they mostly live in developing countries. To obliterate this problem, we need more number of teachers and yet this cannot be a complete solution for the ever increasing problem of illiteracy.

Technology provides the necessary answer to all these problems. Technology of education is being developed with the aim not only of making education more widely available but also of improving the quality of education which is already available. The nature of these emerging educational techniques has been influenced by modern psychology. Piaget's work on behaviour and capabilities of children with his orientation towards the learner and his needs and his emphasis on the importance of maturational factors has been felt everywhere. Likewise Professor B.F. Skinner's work on learning and his emphasis on the importance of 'reinforcement' in the learning situation has created a revolution in the field of educational technology. The relationship between the objectives of education and instructional technology appears to be reciprocal. Developments in technology bring about changes and shifts in educational goals which in their turn, stimulate the emergence of newer techniques.

When we view the educational scene today, we are elated as well as confused. We are gratified at the significant advances in the field of education, in its basic theory as well as in its tools and techniques as these augur well for human welfare. At the same time we are aware of the conflicts and contradictions that have appeared on the educational arena leading to doubt and despair. Recent developments like *performance contracting cost*, *effectiveness* and *accountability* give the noble task of teaching certain aspects of big business. *Learning for mastery* of Bloom, the *open class room*, *the free school* and *open education* are a few newer concepts in education which appear promising and at the same time puzzling. Education which in the early 19th century was seen as the great equaliser of the conditions of men appears not to have been very successful in this task and some educators even talk of 'de schooling' society. All these only serve to highlight the pressing need to evolve an effective pattern of education in consonance with the emerging problems and values of contemporary society with its roots in science and technology.

The recent changes in the concept of education resulting from modernisation have also led to the development of newer areas of educational endeavour. Education is now interpreted not as referring to an initial period of training of youth only, but to a continual and life long process. It is not something that concerns itself with certain aims or philosophies nor does its responsibility end when it has evolved a set of class room techniques for use by the teacher-practitioner. Education today aims at elevating itself to the level of a complete and comprehensive science with broader objectives. It now attempts to relate itself not merely to pedagogy but is conceived as *Androgogy*, which according to Pierre Furter, is the science of training man throughout his life span. Such an enlarged view of education would naturally involve greater and more sophisticated use of instructional technology.

The Educative Process

There is a tendency among some people to define education by its aim or end rather than by its process. Herbart Spencer makes the aim of education more specific by stating that education is a preparation for "complete living". The moment we examine *how* this is to be done; we probe deep into the process itself. Most people will admit that education is a *process*. Sir John Adams says that it is a 'bipolar' process, the two poles being the teacher and pupil. Of the two poles, one is active and the other is passive. The active aspect is sometimes called subjective and the passive, objective. The perceiving mind is the subjective one, while the outside world that it perceives is objective. To keep the educated in a state of activity is the very essence of successful education. At the earlier stages, the teacher may be an active member playing the directing role but very soon, as the process of education goes on, the teacher must liberate himself from the educative process. The less the pupils rely upon the teacher, the better; a successful teacher must enable his pupils to do without him. However, Adamson in his *tri-polar theory* of education, gives the teacher a basic place and role in the educative process.

In actual working process, we find there are at least three aspects that are essential to the concept of education. The first of these, is the universally accepted notion that education implies modification of the educand. The second element is that education is a deliberate process of transmitting all the resources and achievements of a complex society. The third essential quality is that the process of education must always imply the use of an instrument. There must be some means by which the deliberate modification may be accomplished. This instrument is knowledge in its various forms. Teaching is more than mere communication of knowledge. Hence education can be defined as the process of deliberately guiding the development of pupils by the communication and manipulation of knowledge.

Present View on the Importance of Pupil and Learning Outcome

For a very long time, it was understood that mere information was tantamount to knowledge. Traditional education was operated on the assumption that the time consuming steps of learning could be bypassed; that the final knowledge could be transmitted to the learner by a sort of 'intellectual intravenous feeding process'. Schools were considered knowledge shops and teachers, information mongers. Subjects were taught according to logical method of presentation and little attention was paid to the eagerness, curiosity and capability of the pupils. But soon this gave way to child-centered education, thanks to the efforts of progressive educationists like Rousseau, Pestalozzi, Froebel, Montessori, John Dewey and others. As a result, education has become more interested in the 'whole child', all the thoughts, feelings and actions of the individual pupil, in his mental and social development rather than in the slices of more or less information doled out to him in the classroom.

As result of the impact of educational technology, a few ideas have acquired currency in education. One idea is that education should be an individual activity to a much greater extent. Children should not all be forced to go through the same steps of learning at the same speed. The quick students will move faster in their learning whereas the slow learner will need more time.

Another idea is that children learn best in different ways and at different times. Some children may learn better through the use of different learning materials rather than merely listening to an inspirational talk by the teacher. The style of learning may also change according to age. According to psychologists, children learn best if they use their senses in acquiring knowledge. As they grow older, they may be able to learn in a more abstract way.

One idea is that learning can be accomplished faster and better through *reinforcement*. For several years, children learnt to read, memorised tables and performed operations in Arithmetic under the threat of punishment. As a result of the reform movement, positive consequences are now being made effective by proper reinforcement. The well known psychologist, B.F. Skinner, put forward a revolutionary idea that the amount of learning could be enhanced if the knowledge to be learnt were broken into small pieces and each piece presented so clearly that the pupil could not make mistakes. A very slight immediate reinforcement at every correct response would have a tremendous effect on controlling behaviour. The arrangement of tiny bits of knowledge into a logical sequence is called the *programme*. The process is called programmed learning. Programmed instruction is a kind of game in which the student can hardly lose. The more he wins, the more he wants to win and the more he wants to learn.

The Teacher of Yesterday and Today

At the beginning of this century, children were taught in a rigidly formal and stereotyped way. Education was then conceived as a process of transmission of factual knowledge only. The teacher adopted an authoritarian attitude. The children were seated as rows of butterflies transfixed with pins and were stuffed with inert facts. The facts learnt by rote by children were tested from time to time but such tests were neither concerned with conceptual understanding nor effective performance. The main emphasis was on testing memory. A long time intervened between child's response and the teacher's reinforcement. The teacher very often used the verbal method. Verbalism was a disease to which the children were often exposed in the traditional system of education. The teacher had little or no sensory or other audio-visual material to supplement his teaching.

The teacher of today does not consider the child as a vessel waiting to be filled up with facts; nor as a pliable plastic material which can be transformed into any shape enabling him to project his ideas on it. The modern teacher considers each child as akin to a plant and helps the child to grow according to its abilities and aptitudes. He helps the child to learn. He realises that "to teach is to *nourish* or *cultivate* the growing child or to give him intellectual *exercise* or to *train* him in the horizontal sense of directing or guiding his growth". The modern teacher sees education as a procsss of interaction between the child and his environment. Efforts are directed to motivate children to experiment, to search out facts for themselves and to undertake projects in small groups. Activity and experience are the key notes in his scheme of teaching. Children *learn by doing* and *learn how to learn* in groups and also individually. Rigid uniformity has given place to a variety of activities. Teachers realise the constant influence of communication media outside the class room upon the student. Teachers also feel the need for instructional planning and evaluation of learning. They realise the existence of widely different backgrounds, differences in student abilities and interests. Hence the teachers of today realise the need for presenting different learning experiences to suit individual differences among pupils and attempt to use the media and methods generated by educational technology.

The changing role of teacher in education has been the result of a plurality of intertwining influences, philosophical, psychological, social, technological and educational. The basic shift in emphasis from the subject of instruction to the nature and needs of the learner in a complex society had led to the stress on what is referred to as the *mathetic* principle. The term *mathetics* is derived from the Greek root signifying the learner and mathetics is the science of behaviour of the pupil undergoing the process of learning. Mathetics is in contrast to pedagogy whose main interest is in the behaviour of the teacher while instructing pupils. The mathetic principle is also now used in devising programmes for individual learning by pupils.

The shift in emphasis from the teacher to the pupil as the central figure in the process of education and the dovetailing of instructional activities with the realisation of specific and clear-cut learning outcomes has inevitably led to a reassessment of the teacher's role in the classroom. The model of the teacher as the pivotal and dominant figure in education, doling out a variety of information to pupils has today practically disappeared. Such a model of the teacher as the transmitter of knowledge is the traditional one and perhaps is most common. As per this model of teaching, the teacher as instructor selects what is needed from a well-established body of knowledge and passes this on to pupils. Such a teacher-centred view of education, with pupils as passive and silent spectators in the process, is full of defects and cuts at the root of the very basic aims of education; not only does this teaching model ignore the present and future developmental needs of pupils but it also often robs education of its practical and pragmatic value, reducing it to a mass of trivial and often useless accumulation of information. Even if the information passed on by teachers to pupils happens to be of significance and value to them, the passive attitude of disinterest and non-involvement of pupils prevents them from fully comprehending and understanding the information given to them resulting in robbing it of its intended real life applicability. In contrast to such a teaching model, two other teaching models now available stress the active participation of the pupil in the teaching-learning process without minimising the teacher's role.

Jerome Bruner speaks of teaching as 'revealing the structure of the discipline' to pupils. The teacher teaches the concepts and powers of inquiry to pupils, not mere dry and disconnected facts. Bruner's teaching model emphasises the problem-solving approach and postulates the role of sheer intellectual excitement of discovery on the part of pupils as a strong motive for persistent and purposeful learning activity. The current stress on the discovery method, the spiral curriculum and concept of learning for mastery and excellence advocated by Benjamin Bloom which postulates that all pupils can learn and the difference is not in 'how much' but 'how long' to learn, are all the educational outcomes of Bruner's teaching model. However this model also seems to have certain limitations. Discovery can be over-emphasised ignoring the salutary educational principle of 'short-circuiting' educational experiences leading to economy in learning effort. Bruner's teaching model demands substantial cognitive sophistication in pupils to understand the structure of different subjects and youngsters may lack this. Teaching abstractions is rendered more difficult on the basis of this model.

Recent teaching models inspired by the views of Carl Rogers stress empathy, an unconditional positive regard of pupils and a genuine sympathetic approach to pupils in promoting a favourable classroom climate which will facilitate interpersonal learning. Such a teaching model emphasises the quality of human interaction and the degree of interpersonal intimacy and interaction found in the classroom. Ultimately the amount and quality of learning in the classroom depends upon the nature of classroom climate and the existence of learning situations conducive to the development of such a climate. On an examination of the different teaching models available for emulation, it is seen that each of these has some significance and teaching is not exclusively one or the other, though the Rogerian model appears to have certain decided points in its favour, particularly with reference to the objectives of the affective domain as appreciations, attitudes, interests and values. It is equally clear that whatever model a teacher has in view, he or she can and should integrate teaching technology with teaching methods to successfully carry out his or her professional intentions; and the need for instructional technology becomes greater when teachers attempt to translate into practice, teaching models in which the learner's active participation is given particular emphasis. Today's teachers are to train children to lead a full life in the 21st century. Educational philosophy and psychology are sciences and teaching is an art and as William James observed long ago, "Sciences never generate arts directly out of themselves; an intermediary inventive mind must make the application by use of its originality." The future of education depends therefore, directly upon the quality of the intermediary inventive minds of teachers and their ability to invent and innovate. It is in this area that the role of instructional technology assumes vital importance. Teachers need acquire 'media competency' in addition to usual instructional skills.

One of the unchanging functions of the teacher in the educative process is that of communication. The teacher of the past had at his command only the spoken word and/or the written word as tools of such a communication with his pupils. But the teacher of today has at his disposal a battery of interrelated media which he can utilise in the achievement of learning goals. This has become possible through the communication revolution which our century has been witnessing. Such newer techniques and strategies are essential if the newer educational problems created by factors like growing school population heterogeneity of pupils in schools, divergent and even conflicting needs of the learners coming from different socio-cultural areas, the rapid development of new information and the expanding curricular and the social changes arising from modernisation are to be faced and solved satisfactorily by the teachers.

One noteworthy change observed in today's classrooms is the subtle but significant difference in the classroom atmosphere. Psychological studies have clearly revealed the intimate influence of classroom climate and atmosphere in the creation of a fertile learning environment for pupils. In the creation of such an environment the nature of teacher-pupil relationship and the teacher's personal attitudes towards his wards and his professional philosophy as well as life-values are basic. The teacher of the past functioned as an authoritarian figure and he could then afford to do so. But with the changing goals of education and newer psychological discoveries in the field of effective learning, such a style of teacher functioning is not only unproductive but even detrimental to learning. The classic study of Lewin, Lippitt and White has demonstrated to the teacher the long-term benefits of a democratic classroom set up as compared to authoritarian or *laissez-faire* teacher behaviour. There have been criticisms of this study but other investigations have also indicated the importance of the emotional component in learning and generally have tended to support the view that a warm, human and responsive teacher attitude has a stimulating effect on pupil learning. The teacher of today has as such a more difficult and responsible role to play than his predecessor of earlier times.

The Traditional Approach

In the traditional approach, learning and teaching were not analysed and no effort was made to improve teaching as such. Punishment played an important role in the education of children. The teacher often attempted to coerce pupils into reading texts, listening to lectures which were often insipid and recalling as much as possible of what they heard or read. This may perhaps be a valuable achievement; but along with it, certain undesirable educational and psychological by-products have also appeared. The student who works mainly to aversive stimulation finds other ways of escaping. Truancy is one such behaviour. There are also subtler forms of escape. The student though physically present and looking at the teacher does not pay attention; he day dreams. Sometimes the student may counter-attack the teacher. Vandalism is another form of counter-attack. One other effect of aversive control is plain inaction. The student may be stubborn and unresponsive. All these reactions have emotional disturbances too resulting in pupils dropping out of the school system or to be more apt, being 'pushed-out' of it.

Aversive methods also have effects on teachers. The teacher does not teach but holds the student completely responsible for learning. 'Assign and test' seems to be a maxim for these teachers. Examinations are designed to show principally what the student does not know. A teacher is judged by his employers and colleagues by the severity of the threat he imposes on his wards. One is considered to be a good teacher if one makes one's students work hard irrespective of how one teaches them. The important concept of 'relevancy' is totally ignored.

Pragmatic use of Acquired Knowledge

The position has now changed, as teachers have begun to realise that every child is endowed with certain potentialities. He has a "natural curiosity", "a thirst for knowledge" and "inherent wish to learn". The teacher should take advantage of these natural endowments and should bring the child into active contact with the outside world. The teacher of today is considered as a creator and manager of a stimulating environment. The environment or world can be brought into the classroom by the aid of media like films, tape recorders and television. A less coercive practice is to make what is to be seen and heard, attractive and attention-compelling. Materials may be presented in a form in which it is irresistibly learnt. Materials are to be so 'structured' that they are readily grasped. Students must be encouraged to explore, to ask questions, to study themselves and to be creative. The use of concrete aids in teaching facilitates pupil involvement in class activities.

Basic Principles of Learning

There are certain basic principles of learning emphasised by psychologists which are particularly related to the effective use of audio-visual materials in the classroom, and the teacher should bear these in mind.

(i) Each pupil is unique and his response to any experience will also be unique. The teacher, therefore, should use individualised as well as small group instruction along with the traditional large group class instruction, arrange for a variety of alternative and varied learning experiences and organise instruction to allow frequent responses from individuals so as to reveal better the nature and accuracy of their understandings.

(ii) The teacher should remember that perception is the foundation of all learning. Perception is an interpretative process which is based on previous percepts and experiential background. Perception influences thinking and attitudes formation and these in turn condition how individuals perceive.

(iii) Unless the learner participates whole-heartedly in the learning process and unless he becomes involved, he will not be successful. Involvement is related to needs, interests and purposes of the learner.

(iv) The subject-matter, media learning materials and method must be geared to the pupil's interests, abilities and level of learning readiness. Successful teaching with A.V. media involves the determination of the concept level already attained by the pupils and the subsequent use of new experiences by and for the pupils that lead from that level to further higher and wider levels.

(v) The teaching strategies adopted must also be adequate and appropriate. Flexible scheduling of space and time, individual and small group experiences and occasional large group experiences should all form part of the class organisation.

(vi) Creativity and not learning for the sake of learning should be the goal of learning.

Curriculum

The learning situations including media and methods of instruction arise from the *curriculum* of studies. In early days, curriculum was regarded as a list of subject-matter or course of study which the pupils were expected to read, memorise and recite. For a long time, the doctrine of formal discipline determined curriculum content. Experiences gained outside the classroom were not regarded as a part of the curriculum. Till recently, even in developing countries, the curriculum was generally criticised as being inadequate and outmoded and not properly designed to meet the needs of modern times. In countries like U.S.A. and U.K., the traditional curriculum had been severely criticised and satirised as in Peddiwell's 'Sabre tooth curriculum'. Now curricula developments in the field of sciences have been evolved which radically transformed not only the content in these areas but also in the method of approach.

Education is a threefold process of imparting knowledge, developing skills and inculcating proper interests, attitudes and life values. But our schools are often mostly concerned with the imparting of knowledge and even this is not properly carried out. The traditional school curriculum generally puts a high premium on bookish knowledge and rote learning. It provides inadequately for various practical activities that will develop the skills, attitudes and interests of pupils. The Indian Education Commission points out that our "curriculum becomes not only out of step with modern knowledge, but also out of tune with the life of the people". In modern sense, curriculum is interpreted as reflecting the totality of experiences of a child in the school, and not just a programme of studies, though it forms part of the curriculum.

Need-Based Curriculum

Curricula today are constructed on the basis of certain principles, one such is that the materials of instruction should be assembled from the point of the needs of the learner irrespective of the content and boundaries of existing subjects. Efforts should be made to construct curriculum in terms of purposes and activities. The content selected should be with particular reference to the interests and activities natural to the pupils at the particular stage of development. Out-of-school experience must also be considered. Materials must be chosen in such a way as to prepare the learner to meet and control life situations. The curriculum must provide for meeting individual differences. Every individual requires different material in different quantities for growth. Hence stress must be laid on respect for individuality, standardisation, and regimentation must be deprecated.

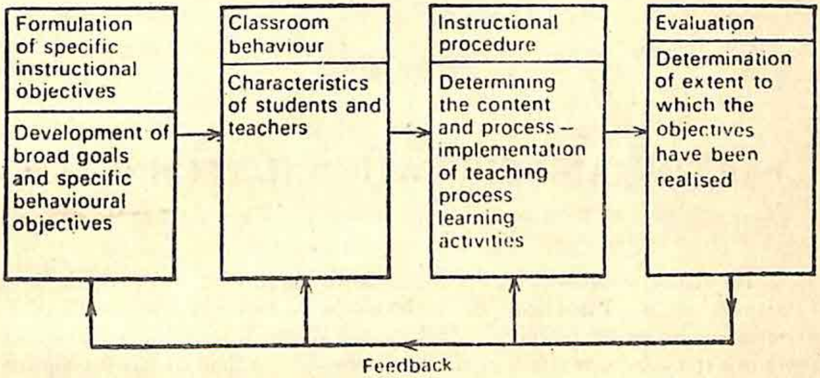
Curriculum: Objectives, Classified into Domains

Curriculum construction depends on certain aims which in turn generate certain instructional objectives. Objectives are the statements which describe the kind of modification that we want to bring about in the learner. Objectives provide the starting point on which all the learning experiences are based. Objectives provide the necessary direction and the foundation for the entire educational structure. There are many objectives of education like knowledge, understanding, application, etc. If learning experiences are based on clear-cut objectives, evaluation is the next step with the help of which whether an objective has been realised or not can be determined easily.

Benjamin Bloom's *Taxonomy of Educational Objectives* attempts to classify educational goals under three domains namely: *Cognitive domain*, *Affective domain*, and *Psychomotor domain*. Bloom has also specified the major objectives under the first two domains. Bloom's scheme classifies educational objectives and relates each objective to specific classroom procedure. It also specifies a sequence of stages or levels of objectives that are matched to a sequence of evaluation strategies. Under cognitive domain, Bloom lists six major levels of objectives—learning facts, comprehension, application, analysis, synthesis and evaluation. The objectives of affective domain include receiving (attending), responding, valuing, organisation and characterisation by a value or value complex. Bloom has also attempted to specify the objectives of the Psychomotor domain. Objectives as such cannot be evaluated directly as they cannot be observed. The learning outcomes must be specified in the form of behaviours as only then they can be observed and measured. Teaching is supposed to modify behaviour of children and hence the specific behavioural objectives must be stated. The curricular development must take note of the several learning experiences which must be specified in behavioural terms so that they can be evaluated.

The following flow diagram (p. 13) based on the teaching model put forward by Robert Glaser shows the paradigm of curricular development.

Behavioural objectives refer to a students' actual ability to *use* what he knows and not mere cognitive awareness. Statement of behavioural objectives includes *conditions* of performance as well as *performance criteria* for evaluation. The teacher should also remember that each type of objective is not something that should be attempted to be achieved separately; all are interwoven in a complex of mental action.


Formulation of specific instructional objectives
Development of broad goals and specific behavioural objectives
Classroom behaviour
Characteristics of students and teachers
Instructional procedure
Determining the content and process – implementation of teaching process learning activities
Evaluation
Determination of extent to which the objectives have been realised
Feedback

An Outline of Teaching Methods used Then and Now

Early developments in teaching methods were based on the need to organise class teaching as efficiently as possible. The teachers were made to acquire the 'tricks of the trade'. The tricks consisted of only the basic elements in teaching like 'how to phrase and distribute oral questions', 'how to apply the Socratic method', 'how to give individual practice and deal with individual answers', how to use the teacher's voice', 'how to use the chalk board for illustrations' and 'how to plan for pupils' activity'. Pupils were taught in larger classes and in groups. Lecture method was almost very popular. In such a situation, the interests of the individuals suffered. Soon as a result of the influence of new educational aims and theories of teaching and learning, newer methods were designed to foster the independence of students in their judgment, originality and creativity in thought. These methods include projects, discovery approach, discussion techniques, tutorials and seminars. Using the communication theory, teachers are attempting to create interest and then present oral and visual experiences. In the development as well as application of such novel techniques, the role of *educational technology* is significant and vital. *Educational technology* has also stimulated teachers to *innovate* in the areas of school organisation, curriculum construction and teaching methods resulting in a variety of newer concepts such as 'non-graded schools', 'modular scheduling', 'flexible grouping' for instructional purposes, 'team teaching' and 'self study procedures'.

CHAPTER 2

LEARNING AND EDUCATIONAL TECHNOLOGY

Education, whatever be its goals and objectives, involves learning. Learning is modification of behaviour which is the result of past experience or prior activity. Behavioural modification arising out of learning may be cognitive, affective, sensori-motor or an amalgam of all these in different proportions. Human learning may occur at different levels of complexity. Robert M. Gagne speaks of a learning at the base and problem-solving at the apex of the hierarchy. Stimulus-response learning of the Skinnerian type, chaining verbal association, discrimination learning, concept learning and rule learning are the other middle levels in the hierarchy. Instruction leading to learning may be in groups or individualised. Individualised programmes consist of learning experiences specifically designed for the individual pupil on the basis of diagnostic procedures employed to determine individual interests and needs. Individual differences which may concern *personality variables* like traits and temperament, *cognitive variables* such as I.Q. and specific abilities, *inquiry variables* like curiosity, experimental attitude, etc., and *sequencing variables* involving random or logical sequencing of instructional information, demand individualisation of learning. Whatever be the level of learning or type of learning, the basic learning experiences or the *inputs of learning* have to reach the pupil through his senses. As such the senses along with the intellect are vital to learning. In one way senses appear to be even more important than cognitive interpretative abilities for learning as there could be nothing in the intellect which has not been transmitted through the senses.

Our senses are the gateways to acquire knowledge. These receptive mechanisms vary in their functions as much as the individuals themselves. The receptive mechanisms feed us the necessary data, the sensory impressions. The natural way of learning by children is principally through the employment of senses. If a new object is given to the child, the child makes sounds with the object, bites it and tastes it, looks at it closely and slowly learns about the object by making use of its senses. This is the reason for emphasising sense training in Montessori method.

Sense of Sight

Of all the senses, sense of sight is most vivid and provides rich experiences to the individual. Nearly 80 per cent of the experiences that a person gains in this world are received through this particular sense. People who have lost the power of this sense, generally compensate to a very large degree by the tactile sense. Impressions created by the sense of sight cannot easily be effaced. A 'visual' will not only attract the attention of pupils but also hold it for long as it appeals to the sense of sight. Visual experiences are also more effective than verbal experiences. Although the learning process uses the senses as avenues to reach our minds, it is important which sense is used to conduct the message. Experience and research has shown that the following figures are generally valid.

We learn:

1.0 per cent through *TASTE*
1.5 per cent through *TOUCH*
3.5 per cent through *SMELL*
11.0 per cent through *HEARING*
83.0 per cent through *SIGHT*

We remember:

20 per cent of what we *HEAR*
30 per cent of what we *SEE*
50 per cent of what we *SEE AND HEAR*
80 per cent of what we *SAY*
90 per cent of what we *SAY AND DO*.

This importance and superiority of visual impressions and their interpretation over other sensory channels of information is exemplified today in the stress on what is referred to as *visual literacy*. Visual literacy refers to a group of vision competencies one can develop by seeing and at the same time hearing and integrating other sensory, verbal and learning experiences". Visual literacy training, if given to young pupils, will induce motivation and skills in them in expressing themselves first in visual terms and later on spoken and written language. John L. Debes, in explaining the concept of visual literacy, remarks that competencies associated with visual literacy is fundamental to normal human learning. When developed they enable a normally literate person 'to discriminate and interpret the visual actions, objects and symbols that he encounters in his environment'. Through the creative use of these competencies he is able to communicate with others and comprehend, appreciate and master works of visual communication.

The following competencies appear to be involved in visual literacy: to read visuals with skill, to write with visuals expressing oneself effectively, to be familiar with the tools of visual literacy and their use, to appreciate the master works of visual literacy and to be able to translate from visual and verbal language and vice versa. Visual literacy appears to have special benefits not only for those with limited verbal skills but also equally useful for verbally competent and articulate students. The various components of educational technology such as still pictures, drawings, graphics, displays, demonstrations etc., are all tools and channels of visual literacy.

Perception and Formation of Concept

Perception refers "to the way in which man senses or becomes immediately aware of his environment". Although knowledge about the world is gained through the senses, sensory impressions themselves are not enough to give a suitable understanding of the object perceived. It is the brain that receives the impressions and interprets them, which then become organised into meaningful understanding. Thus any given perceptual event is the result of multiple sensory messages. Perceptual events do not occur in isolation; they are continuous. As a result of constant sensory stimulation, experiences are arranged and rearranged, shuffled and reshuffled, selected and reselected and organised into a convenient combination of patterns. This process finally leads to formation of concept. In general, the understanding of the things and events of the world are based on sensory experiences and the physical objects, as we know them are products, of our own sensory perceptions.

Hence the process of understanding must begin with perception. Or in other words, conceptualisation has its basis in concrete experiences. Where the concrete basis for abstract conceptualisation is lacking, acquisition of the concept by the individual is inadequate or may not take place at all. This is the reason for emphasising maximum concretisation at the lower levels of education so that it will lead to better abstractions in the higher courses. Without a sufficient conceptual foundation, the learning process is impaired and the thinking process is also very much affected.

Value of One Sense Over Another

A problem may be raised regarding the effectiveness of a particular sense over the others. Actually, our sensory experiences are mixed. When we listen to the teacher, we are not only getting the aural experience but also observe his facial and body gestures. The characteristics of a particular object may be studied completely by not only making sounds, but also observing its physical features including the weight, smell, colour, etc. So long as our sensory mechanisms are functioning normally, we learn quite as readily through one sense as another. The teacher must determine which method of presentation is to be preferred to the particular age-group. The relative values of the various aids must be analysed while deciding to use it. The aid must make the point clear to the learner interestingly with economy of time.

Multi-Sensory Approach

Monotony can be a powerful deterrent to learning. In a typical classroom, we find the teachers talking to an ebullient group of children all the time. It has been recognised that students grasp ideas better through concrete aids like pictures, diagrams, practical work, demonstrations, field trips and the like. In the absence of these various aids that appeal to the senses, children find the school work dull and dreary and hence these may also cause them to drop-out of school. Further, to meet the individual differences in a classroom, the teacher must resort to various types of aids that appeal to the different senses. Even among the aids, there are quite a lot of them which appeal to two or more senses simultaneously. For example, while looking at a television programme, or a motion picture, students not only listen but also see. When such aids that appeal to different senses are used, they not only reinforce but also add effectiveness to the teaching procedure.

Audio-Visual Aids

Almost every educational reformer has expressed deep concern over the excessive use of words that carry the shadow of meaning but not the substance. Several educationists have struggled to make education realistic. About three centuries ago, J.A. Comenius prepared the first "visualised" text book which contained some 150 pictures. "Let the pictures be a source of delight to the children and let them become familiar with them befcre they enter school", was his theory. Later J.J. Rousseau (1712-1778) criticised the teaching of his days and condemned the liberal use of words by teachers. According to him, the teaching process must be directed to the learner's natural curiosity. Rousseau's theory was put into action by Pestalozzi (1756-1827) in his 'object method'. He became interested in basing instruction on sense perception. Although attempts on the use of concrete aids were made sporadically, intensive development in audio-visual education has started only recently in the twenties of this century. Educators investigated the possibility of using motion films and by 1929, sound films were produced. The impetus to the movement was given during the Second World War when the armed forces suddenly faced teaching tasks of staggering proportions. Today it has been proved beyond doubt that audio-visual aids can contribute effectively in teaching.

Audio-visual aids are the different types of tools that appeal to the sense of hearing and vision and are used in classroom for presentation of abstract information. These materials may be used to convey meaning without complete dependence on verbal symbols or language. Thus according to definition, a text book does not fall under the category of audio-visual grouping of instructional materials, but a text book illustration does. Some audio-visual activities like going on a field trip, dramatising an event in history, or demonstrating an experiment are in the nature of processes or experiences. Some like motion film or filmstrip need a projector to handle with. Some others like a chart, a photograph or picture need no equipment and can be directly used. Experiences of this type will be classified under visual category. Magnetic tape or disc recordings belong to audio category. Hence the term 'audio-visual aids' designates in common usage both processes and material things. Educators now often refer to describe the field of audio-visual education as 'educational communication technology', 'audio-visual media', 'learning resources', and 'instructional or educational media'. The terms 'A.V. materials', 'instructional media' or 'educational media' mean the same thing. All these are implied by the term *Media* generally. More specifically 'media' refers to films, filmstrips, recordings, etc., and programmed instruction, computer assisted instruction, educational TV are designated as *Methods.*

The replacement of the older and perhaps more familiar term 'Audio-visual materials in education' by the newer term *Educational Technology* or *Instructional Technology* is mainly due to the dynamic expansion of the field of A.V. education and the exciting new developments that promise much more for the future. The main objective of the use of educational technology is the improvement of learning. However this purpose can be fully achieved only when the vital role of the individual teacher in adding the necessary human, personal factors necessary for the best use of technological hard and software is understood.

The Fourth Revolution

Eric Ashby (1967) has identified four revolutions in education.

1. The first revolution occurred when societies began to differentiate adult roles and the task of educating the young was shifted, in part, from parents to teachers and from home to *school.*
2. The second was "the adoption of the *written word* as a tool

of education". Prior to that time, oral instruction prevailed and it was with reluctance that "writing was permitted to coexist with the spoken word in the classroom".

3. The third revolution came with the invention of *printing* and the subsequent wide availability of books.
4. The fourth revolution is the development in ***electronics***, notably those involving the radio, television, tape recorder and computer. Behavioural scientists have joined the fourth revolution and have pointed out the importance of defining learning objectives and suggesting ways in which natural learning process can be utilised in the presentation of subject-matter by employing these vast resources.

Definition of Educational Technology

Educational technology implies a behavioural science approach to teaching and learning in that it makes use of pertinent scientific and technological methods and concepts developed in psychology, sociology, communications, linguistics and other related fields. It also attempts to incorporate the 'management principles of cost effectiveness and the efficient deployment and use of available resources' in men and materials. Educational technology as a concept does not necessarily imply the use of machines and other items of hardware. Experience has shown that more often than not they involve such media, equipment and resources.

In short educational technology, in its wide sense as understood today, includes "the development, application and evaluation of systems, techniques and aids in the field of learning." As such its scope encompasses educational objectives, media and their characteristics, criteria for selection of media and resources, management of resources, as well as their evaluation.

The growing use of educational technology in today's schools has helped to release the teacher from the routine role of 'information giving' so that he can devote his time and effort to the more important task of planning, arranging and evaluating learning experiences and outcomes and to encourage, enthuse, guide and counsel pupils. The various technological media are used to communicate the needed factual information to pupils and they are capable of doing this perhaps more accurately and efficiently than the teacher. So today 'pupils acquire knowledge through the various media and behavioural changes via the teacher'. Another noticeable trend is the creation of multi-media learning environments in the classroom which involve the use of a variety of interrelated learning experiences. This implies "the selection and use of appropriate sequences of interlinked A.V.

or instructional media learning experiences which reinforce and strengthen one another in furthering the progress of the learner".

The Psychology of Using Teaching Aids

There is an old saying which reads

> "I hear, I forget;
> I see, I remember;
> I do, I understand."

I Hear, I Forget

The traditional teacher depended too much on verbal exposition. The pupil hears and forgets. Further, unless the individual has pragmatic imagination it will be *difficult* for the individual to *visualise* objects and events however vivid the verbal description is. It is highly possible that concepts formed will depend upon the nature of background experience of the individual. It is highly necessary particularly in science and technology that knowledge gained by an individual is accurate, where considerable visualisation of objects and processes are necessary and formation of accurate concepts essential.

I See, I Remember

As a sensory organ, the eye is very highly developed when compared to the other sensory organs. Further primates and man, due to location of the two eyes in the front of a flat face have the additional advantage of perceiving depth. This is called the binocular vision. The human eye could differentiate very minute differences in colour and shade. It is quite natural that the knowledge gained through the sense of sight is more vivid, accurate and permanent. Hence what one sees, one remembers. More than 85 per cent of our knowledge is gained through our eyes.

I Do, I Understand

When one is engaged in any practical activity, involving physical work (doing practical work in the laboratory, workshop or in the field) all the senses are used to perceive. Knowledge is through all the senses. Hence inflow of knowledge is through many channels and naturally should be fast, complete and more accurate. This is learning by direct experience. Project method involving creative work will provide direct experience in a natural way. (The work has a meaning to the pupil. The outcome is pragmatic. Lot of self activity is involved.) It is an ideal method of making pupil acquire complete knowledge.

Psychological studies of effective learning emphasise the importance of first-hand concrete experiences involving sensory contacts as the starting point of learning, which later only proceeds towards greater and greater abstraction. A pupil profits most from instruction when he becomes involved through his own interests and purposes and such an involvement is possible when concepts and principles are introduced to him through well-chosen educational media appealing to the different senses. Such a pupil will also act creatively. The teacher of today has at his command an array of aids some ready-made and some fabricated, by the teacher. Using these teaching aids, the teacher can plan learning situations and be sure of realising his objective. The teacher can make use of specific audio-visual aids to suit his purpose. The aids being *concrete* will be able to secure the attention of the pupils, motivate, enable the pupils form *accurate concepts*, ensure *permanent retention* of the knowledge gained. A teacher using appropriate aids can make clear a difficult concept even to a below average pupil very easily.

The activities during a class session should be varied to prevent boredom, purposeful for effectiveness and pre-planned to achieve the set objective. The teacher to effect maximum learning should make the pupils look, listen and think. He should secure their attention and maintain the same throughout. Interest should be created and learning should be speeded up, fixed and consolidated. Knowledge gained should be transferable and utilitarian. The teacher of today makes sure of all the above outcomes by making use of the right type of A.V. aids at the right time in the right way.

The teacher uses verbal exposition, which is the least effective method of imparting instruction, to a minimum extent, supplement the same with judicious use of proper teaching aids and providing ample direct experience where knowledge is gained through multi-sensory media.

Media and Methods of Teaching

The teacher practitioner is often puzzled when he is introduced to the many types of audio-visual aids available to him. Too often the novice in the art of teaching looks upon the hardware of educational technology as a convenient substitute for professional planning and competency. So, even at the outset, it should be made clear to the young teacher that different media and methods are suitable for realising different learning outcomes, that the effectiveness of aids depends not only on the materials provided but also on the techniques used and the ability and resourcefulness of the teacher is as important in the classrooms of today as they were in the traditional classrooms. For some instructional objectives the chalkboard will suffice; for some others a brief lecture correlated to a suitable and simple

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demonstration will be enough; while for realising certain other learning outcomes the overhead projector or the sound film projector may be apt. "As new devices are developed, it is quite common for each to be heralded as the panacea for educational ills." The overhead projector, the teaching machine and the educational TV have all had their day. However the fact remains that the teacher must determine how each device can uniquely serve his specific teaching needs.

Competence in the art and craft of classroom instruction requires mastery of many methods and modes of communicating information and influencing pupil's behaviour. These include not only the special techniques associated with the teaching of specific subjects but also general organisational strategies needed for running the classroom : keeping order, facilitating communication, catering to individual differences among pupils, etc. New instructional methods develop from different sources such as psychological research, pedagogical theory, academic disciplines, outgrowth of teacher's ideas and experiences, impressions of how learning ought to occur. Whatever be the source and whatever be the nature of instructional method adopted A.V. media help to support and supplement the teacher's work. Only, the teacher should not relinquish his responsibilities and believe in the view "let multimedia do it", as without proper planning, supervision and follow up the results may be meagre or even negative.

Dale's Cone of Experience

All the experiences that human beings derive are mainly from three sources, namely (i) direct sensory contact which involves *doing*, (ii) pictures or some other forms of representation of objects which involve *observing*, and (iii) oral or printed words which involve *symbolising*. Of these three possibilities, the third is perhaps of least value from the point of view of teaching the young learner. All the learning experiences which can be utilised for classroom teaching are shown by Edgar Dale in a pictorial device—'pinnacle form'—which he called the "Cone of experience". If we travel up the pinnacle from its base, everything has been arranged in the order of increasing abstractness or decreasing directness. The experiences included in the cone are as indicated below.

1. Direct, purposeful experience that is seen, handled, tasted, felt, touched and smelt, i.e., the experience that is gained through the senses. These experiences are not only direct but are also purposeful. Purposeful means that the experience are active with a purpose. "An ounce of experience is better than a tonne of theory, simply because it is only as an experience that any theory has vital and verifiable significance." Objects are the reality. Hence they are preferred in teaching as they provide the means to establish correct initial concepts in the minds of pupils. Specimens are excellent visual aids but they cannot be a substitute for the real object as they are only a sample or part of an object.

2. *Contrived experience* like working out a model, which is editing of reality and differs from the original either in size or in complexity. The simplification of the real object becomes necessary when the real thing cannot be perceived directly. The real object may be too big or too minute; may be obscured or confused or concealed. In such circumstances, the limitation is preferred for better and easier understanding.

3. *Dramatic participation* in which certain realities of the past we can get as close as possible. Dramatisations are available in a variety of forms. There are the carefully rehearsed full length plays, complete with costumes and scenery. Puppet shows, pageants, pantomimes, tableaux, dialogues, spontaneous acting and mock conventions are other forms of drama. In each of these activities, one can be an observer or a participant. The experience is more meaningful when one actively participates in the dramatisation than one who merely watches. The observer is not compelled to 'feel like' the character whereas the actor must try to 'become' the character that he portrays. His appearance on the stage must be dramatic in the sense that it must be stirring, compelling attention and making a strong emotional impact on the audience. Proper costumes definitely heighten the effect of dramatisation in three ways.

1. It compels attention.
2. It helps to identify the actor—young, old, type of work or profession of the character.
3. It enables the actor to feel and play his role better.

Types of dramatised expriences include the following :

The Play : This kind of drama vividly portrays important ideas related to social problems.

The Pageant : This is a kind of community drama, usually based on local history.

Pantomime : In pantomime, the effect depends upon the movements of the actors, for they do not speak.

Tableau : This is a picture-like scene. The movements of the characters are restricted and they stand-still silently.

Puppets : These present ideas with extreme simplicity, without elaborate scenery or costume. Puppet show has mass appeal and is used to have great advantage at all levels of education. Shadow puppets, simple rod puppets, hand puppets and stringed puppets or marionettes are the different types of puppetry.

4. *Demonstration experiments* : Certain complicated processes can be performed by the teacher for the benefit of pupils who are reduced to the position of passive observers. The demonstrations may be set up on a demonstration table which is usually kept in an elevated place so that all can closely watch the demonstrations. In the lecture-demonstration approach such demonstrations are interwoven with the lecture

5. *Field trips* : This forms the connecting link between the school and the community. Numerous opportunities with an extensive array of materials are offered by the community which could very well be utilised for teaching. The extent to which these resources should be used will depend upon their potential usefulness in supplementing the classroom teaching. This technique is unique in that the pupils gain first-hand experiences with the things and phenomena which cannot be brought into the classroom. Only when this is not possible, the teacher should have resources to other visual aids. But in our present system of mass education this is quite impossible to arrange too often.

6. *Exhibitions and museums :* When it is not feasible to go out into the community, it becomes exceedingly important that we bring the outside world into the classroom by means of exhibits and concrete representation of things. The science department of every school should have a museum. The natural instinct for collecting and hoarding found in school children should be mobilised in building the museum. A well-developed museum is not only an asset to that school but also a motivating and vitalising factor for the particular subject.

7. *Television :* Television can bring a dimension beyond the range of motion pictures. It can bring the real event as it actually happens. In the case of motion film, the event has already been filmed and hence the outcome is known. But in a telecast, the event is seen as it unfolds with the outcome uncertain. Otherwise, the television broadcast is 'history in the making'.

8. *Motion pictures* : They are increasingly being used by teachers nowadays. If these are carefully prepared and properly used in the classroom, the results that are obtained are quite comparable with those of ordinary teaching. Motion pictures with sound system would yield good results in teaching all the subjects in the school curriculum.

9. *Radio and recordings* : The advantages of radio as an educational aid are quite numerous and its functioning as "one way

communication" which is a drawback, has been overcome to some extent by means of recordings which can be played and the reactions of the pupils observed.

10. *Still pictures, pictures, illustrations, stereographs, slides, filmstrips and micro projections* : These can be either projected on a screen by means of projection machines and accessory equipment or given for individual study.

11. *Designed materials :* Maps, charts, graphs, diagrams and cartoons when properly employed tend to promote a keener interest and a better understanding of concepts.

12. *Verbal symbols :* This is the usual 'chalk and talk' method which requires great thinking. The word, or idea or concept or scientific principle expressed here has no resemblance to the objects for which they stand. Even here a distinction should be made between the written and spoken word. According to linguists, the spoken word is primary and printed word is secondary. "Printed words are only the symbols of symbols". Jespersen says that "A written word is mummified until someone imparts life to it by transposing it mentally into the corresponding spoken word." Hence the spoken word should be placed lower than the written word in the cone.

It can thus be seen that the opportunities afforded by the sensory aids are very great and that it all depends upon the ingenuity of the teacher as to how he could exploit the learning situation by the right use of the proper aid. Nevertheless the richer the teaching materials, the more will be the teacher's responsibility to correlate and plan his teaching. The following *general principles* may however serve as guides to the use of these aids.

(1) There are three stages in a learning process when an educational aid is used to supplement the ordinary teaching, viz., (i) preparing the pupils for the learning experience, (ii) reinforcing the values while the pupils are sharing the experience, and (iii) relating the experience with the lesson and thus stimulating further learning.

(2) The aids must be adapted to the intellectual maturity of the pupils and to the nature and extent of their previous experience.

(3) There is no best aid which has all the advantages. Most visual aids suffer from some psychological limitations. The teacher should be familiar with the advantages and limitations of the various types of sensory aids.

(4) Visual aids should not be considered as substitutes for oral

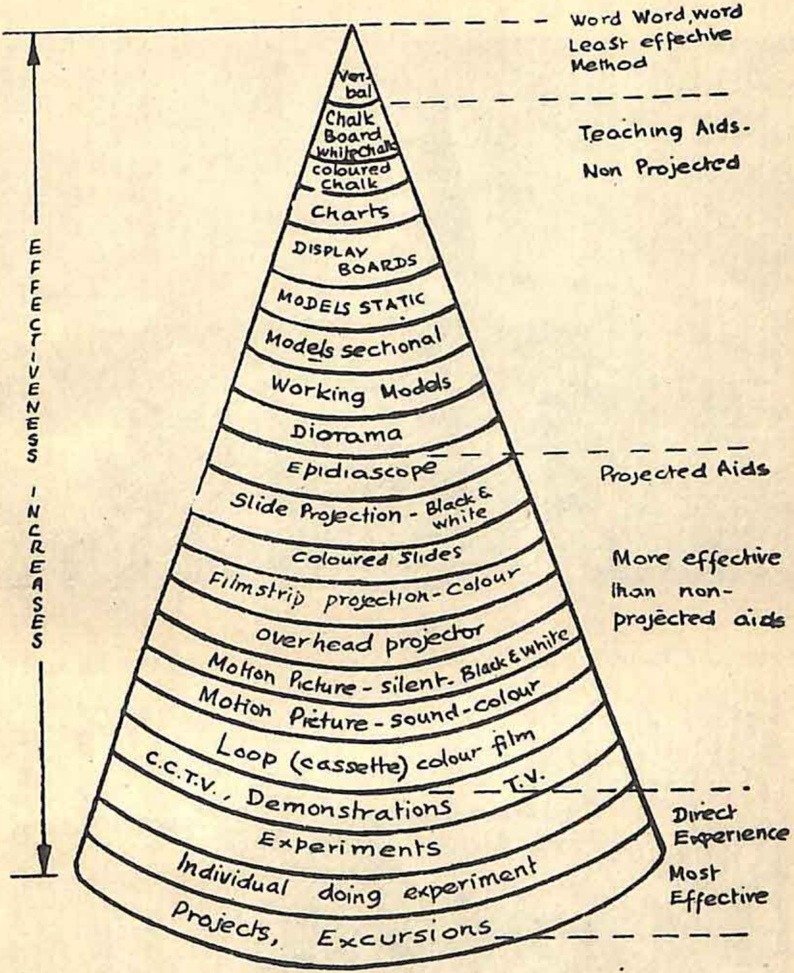
and written methods of acquiring knowledge. They should be used to supplement the classroom teaching.

(5) Visual instruction in the classroom should not be confused with entertainment. The effective use of an aid depends primarily on careful planning by the teacher.

(6) In all cases, the time and effort on the use of a particular aid in preference to others must always be justified.

A Practical Cone Classifying Different Aids

The 'Cone' proposed by Edgar Dale was the earliest attempt to classify the audio-visual aids according to their effectiveness in communicating ideas. The cone classifies sensory aids in terms of greater or less concreteness and abstractness as learning experiences. The cone device should not be construed as an accurate arrangement of the learning experiences systematically from base to pinnacle. Field trip has been classified as an experience involving only observation and hence has been placed much high in the ladder. Actually, field trip provides rich, first-hand experiences in some instances and hence should be classified under 'Direct, purposeful experience'. Similarly, projected aids are considered to be more effective in teaching than the non-projected aids. But projected aids occupy a top position in the pinnacle, signifying thereby that they are comparatively abstract experiences in relation to direct experience. The following is a practical cone classifying different aids with reference to their relative effectiveness.



RELATIVE EFFECTIVENESS OF TEACHING AIDS

Fig. II.1

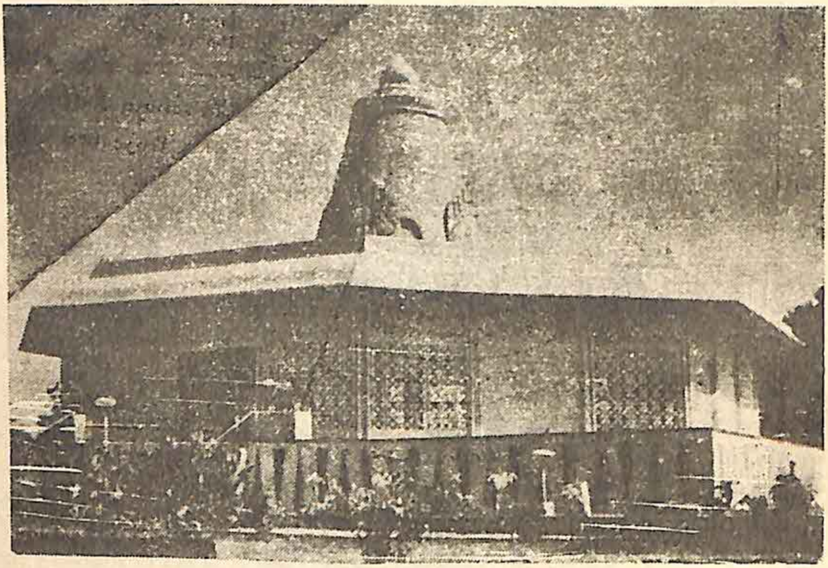


Fig. II. 2

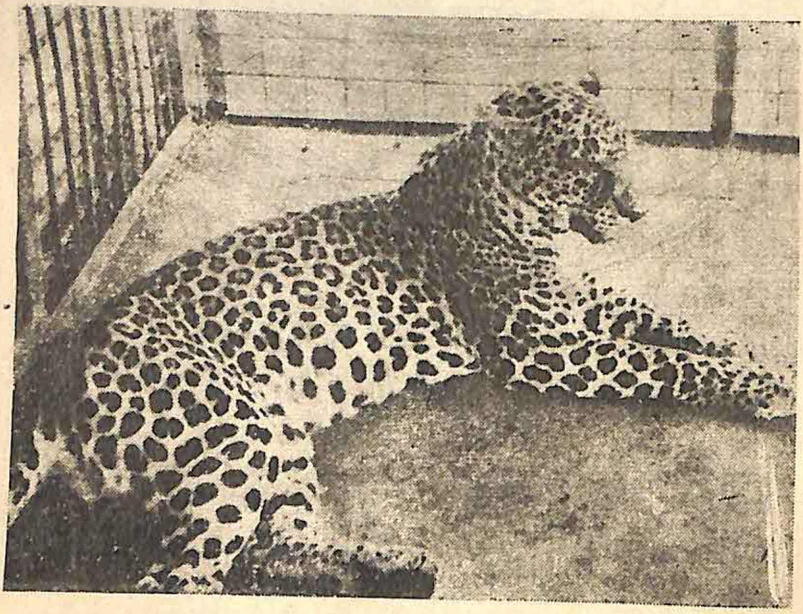


Fig. II. 3
When are these to be Used

CHAPTER III

COMMUNICATION AND INTERACTION

'Communis' is a Latin word, meaning 'common'. Hence communication is having common experiences with people. The word communication means a wide variety of things to different people. The following are some of the widely accepted definitions for communication.

> "Communication means *sharing of ideas and feelings* in a mood of mutuality".
>
> "Communication involves *interaction* which encourages *give and take*". This provides feedback to persons involved in exchanging ideas.
>
> "Communication is a process of sharing of experiences till it becomes common possession"
>
> "Effective communication is a two-way process including feedback and interaction".

It is rather difficult if not increasingly impossible to provide children with actual first-hand experiences as the world becomes increasingly complex. Obviously some substitute experience must be evolved and used to enable children to understand and conceptualise their world. This is the essence of *communication* as an integral part of teaching.

Theory of Communication

The basic communication model involves an informational or interpretive process in which messages, information or reaction to information travel from the initiator to the receiver through the route called communication channel. The message conveyed by the teacher and/or the educational media may be verbal or visual and the receiver may listen, see or examine and react in other ways. The communication channel in the classroom should ideally carry both messages and counter-messages ; it involves initiation, reception and response which serves as feedback. The communication channel must be kept wide open, as only when the teacher and pupil are able to communicate clearly and without interference can understanding and appreciation ensue. Usually the more varied and appropriate the sources from which messages originate the stronger and more valid will be the responses and counter-messages that occur between the teacher and students or among students themselves. But unfortunately many interferences and communication barriers arise which impede the smooth flow of communication between the teacher and his pupils in the classroom. Some of these come from out of school agencies as commercial and entertainment media such as advertisements, magazines, radio, TV, etc. Others originate from psychological causes arising out of the interactive classroom procedure itself and as such are very difficult to tackle. These include excessive verbalism, lack of related experiences necessary for comprehending the new material presented and consequent attempts to relate the new material to seemingly relevant experiences resulting in what is called 'referent confusion', day-dreaming, limited perception resulting in limited understanding as well as physical discomfort of the classroom environment. Educational technology uses man's psychological and technological knowledge extensively to break-through such barriers to communication in the classroom.

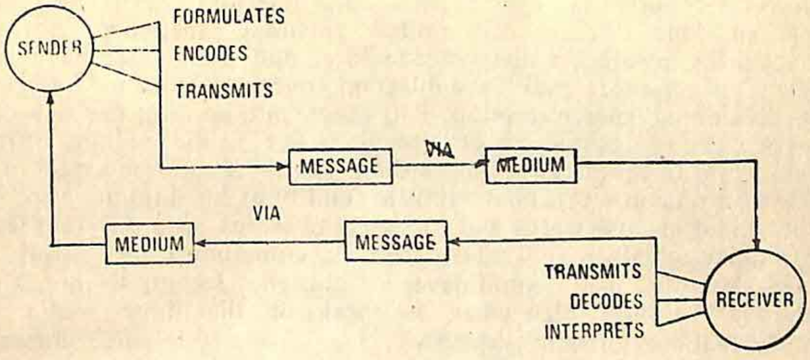
Communication Cycle

There are essentially four components in the process of communication. They are :

1. *Sender or source*, technically called as '*encoder*',
2. *Message* or *signal*,
2. The *Medium* or *channel of communication*, and
4. The *Receiver* or destination or '*decoder*'.

In this process, the source must have correct information and transmit accurately at optimum speed. The message may be designed for a single person or a group of people. It may be conveyed by expressions, gestures, spoken or written symbols or by hand-drawn or photographic pictures. Every medium exerts its influence and its peculiarities on the message and in this sense becomes a part of the message. The receiver must understand the message or in other words, must decode it or interpret it and must produce a desired response, or react which must be received by the sender. This is called the *feedback* channel.

The *communication cycle* can be represented by the following diagram :



Types of Communication

There are three types of communication.

1. *Speaking—Listening*

In this type of communication, interaction is face to face as in the case of listening to a lecture. There are occasions when the listener can share the feelings of the source in the same way as in the case of eye to eye contact. An example for this type of communication is listening to the radio programmes.

2. *Visualising—Observing*

The observer is physically separated from its producer and yet is able to feel the impact of the ideas conveyed as in motion film or television. Communication can also take place more effectively by face to face contact with the source as in the case of dramatisation where facial expression and gestures produce a greater impact than in the earlier case.

3. *Writing—Reading*

In this type of experience, the 'decoder' is physically separated from the 'encoder' all the time and yet the decoder is able to enjoy and appreciate the feelings of the author.

The arrows both ways in all the three types of communication, indicate that communication is interaction, sharing and circular or cyclic process.

Communication in the Classroom

Communication in the classroom is to a considerable extent carried on through language—spoken and written, with the former playing a relatively greater role. According to Jean Piaget, the early speech of children is 'ego-centric'. They interpret words and use them in terms of their own limited personal experience, not yet grasping the possibility that other children and adults who have had different experiences may have different concepts. Only by 7-8 years does 'socialised' speech develop. This takes into account the views of others. The ego-centricity of speech is due to the inability of the young child to think about more than one thing or one aspect of a thing at a time and this characteristic conditions his thinking also. So young children use words and understand words in a different way from older children and adults and in communicating with them in the classroom this should never be ignored. Jerome Bruner also indicates a similar view when he speaks of the three stages of 'intellectual development', 'enactive', 'iconic' and 'symbolic' representative stages and states that using language as an instrument of communication and thinking is clearly seen in the symbolic stage. In trying to communicate using language in the classroom, teachers may benefit by the views of David P. Ausubel regarding 'advance organisers', regarding learning and retenion of meaningful verbal material. The advance organisers roughly correspond to broad categories within an unit of learning and these permit students to integrate and relate material presented.

Good teaching is more than mere communication. It is not enough if the child merely repeats the same word as conveyed to it. The teacher's concern is that the child should recognise the word, understand the meaning and use it appropriately with correct spelling on future occasions. True learning has occurred only when the act of communication has succeeded in making permanent and meaningful addition to the student's communication skills. Classroom communication is not mere one-sided presentation of facts ; it requires *intercommunication* between student and teacher. There must be reaction and interaction with constant reciprocal feedback.

Teachers should know several things about communication. Classrooms are set up for the purpose of communicating and not for dictating teacher's ideas on the young and growing minds. Developing communication skills in children is the basic concern of the school and hence teachers must provide ways and means of developing and improving the skills. Teachers must realise the constant influence of several communication media outside the classroom upon the student. The words that the children seem to possess before entering school were all learned through various media. Teachers must capitalise on the students' conditioning to these media and must relate them to the school activities. Communication can occur only when the teacher and his pupils share common meanings and experiences.

Pupils with widely different backgrounds, different abilities and interests attend school today. Further the teacher has to manage with the vast explosion in knowledge. Students have too few opportunities and too little time to explore the vast subject-matter included in the curriculum in depth. To meet these challenges, the teacher has to make use of new and improved communication devices in the classrooms. Modern technology has provided films, filmstrips, radio, television, magnetic tapes, stereoscopic pictures and vast myriads of communication devices. These materials and techniques can be divided into two categories.

1. Those that are effective for use with groups containing individuals of varying abilities, and

2. Those that can be used advantageously in individualised instruction with a minimum teacher assistance.

Barriers to Communication : Communication may fail in certain instances as in the following :

(a) When facts are to be presented based on different socio-economic backgrounds.

(b) When facts are based on alien time dimension and space dimension.

Teachers have extra problems as communicators as they have to be sure of their messages reaching *all* pupils regardless of the kind of interference present in the classroom. These barriers can be overcome to a very great extent by means of various audio-visual aids. The so-called mass media of communication like radio, motion picture, films and television reach mass of people at high speed with low cost. They are very flexible in their use and are excellent in quality. Verbalism which is a disease usually contracted in schools can be eradicated only when learning in a classroom is made real, meaningful, concrete and first hand. Audio-visual materials if properly used, offer great opportunities for improving learning. For bridging the communication gap, use of audio-visual materials is not the best reason but only the practical reason. Now such media may be used flexibly in instructional systems resulting in greater benefits to pupils.

Lecture and Lecture-Demonstrations as Communication Interaction Methods

The Lecture Method has been the earliest known method of instruction. Books were not available then and manuscripts were rare and hence lecture method was used for instruction. At present the method is used to a greater extent in colleges only. Many pupils, particularly young persons, cannot stand sustained narration since their span of attention is limited, but they are instinctively equipped to appreciate change in theme. An informal talk, punctuated by suitable questions and made spicy by the use of audio-visual aids providing a more vivid picture, will be able to secure sustained attention of the pupils and will result in considerable amount of learning. Yet the lecture method has certain advantages :

1. The proper perspective and orientation of a subject can be presented and the general outline of the scope of the subject can be brought out.
2. Many facts can be presented in a short time in an impressive way.
3. When lectures are presented in a series it is possible to stimulate very good interest in the subject.
4. Greater attention could be secured and maintained, as interest leads to attention.
5. Spoken word has greater weight than mute appeal by books.
6. The language may be made suitable to all the members of the audience.
7. Lectures can be advantageously made use of for presenting a number of facts belonging to different subjects and impression thus created would be of long-standing value. Lectures facilitate inter-disciplinary approach to topics.

Limitations and Disadvantages

1. It is waste of time to repeat the matter already present in books. Independent reading will be disturbed as a result of this.
2. The teacher to make the lecture impressive may care more for manner and style but very little for matter or content.
3. If the lecturer is very fast in lecturing the pupils cannot easily take notes and will not have any written record of the salient points made out.
4. A lecture delivered in a style not easily understood by pupils will serve no purpose.
5. Lectures are said to kill the initiative of pupils and their problem solving attitudes disappear.
6. In the classroom where the lecture method is used there will be mental inertia--non analysis of the lecture will result in

non-cooperation between the minds of teacher and pupils.

7. The lecturer may lose sight of subject-matter and go in foı oration.

8. Dictation would become prominent in the course of lectures.

To Make a Lecture Effective : Certain precautions have to be taken :

1. Matter of the lecture should be systematised and summary developed at each stage.

The following aspects are to be taken into account and stressed :

(a) The objective of the lecture.
(b) The outline of the lecture.
(c) The pertinent illustrative devices.
(d) How to capitalise the appreciation of humour and experience
(e) To evoke respect by teacher's personality.

2. *Presentation*

(a) The speed must be measured and considered.

(b) Important points must be emphasised by loud and impressive statements which should be recapitulated at the end.

(c) The manner of presentation should be cheerful—not too humorous nor too rigid.

(d) Pronunciation must be as far as possible approaching the correct one.

(e) A sweet voice always makes a lecture successful. Pupils should be encouraged to take notes during lecture. Pupils can take notes using (1) the outline method noting bare outlines—heads and sub-heads (2) salient point method—noting pertinent points only (3) verbatim method—writing down all that is told—the entire matter (4) short hand method, lecture can be used for presenting biographies of scientists and engineers, scientific phenomena in a nutshell—Background for literary appreciation, historical narratives etc.

3. Digest of extensive readings on the part of the teacher enhances the value of the lecture.

4. *Lecture Demonstration Method :* In this method, the spoken word is supplemented with demonstration using varied aids resulting in auditory and visual learning; concrete demonstrations through aids is reinforced instruction through two channels, eye and the ear.

Development demonstration involves getting answers from pupils as the demonstration proceeds gradually in stages.

Advantages of Lecture-Demonstrations

1. Much matter could be covered in a short time.
2. Much time and energy of pupils and teacher is saved.
3. Only one set of apparatus necessary is required; so the lecture demonstration is economical.
4. Delicate and dangerous experiments which require delicate manipulation can be performed by the teacher only with pupils as active observers.
5. Demonstration will be useful before pupils launch on independent work.
6. Demonstration will be most effective to stimulate the thoughts of pupils.
7. By the expressions on the faces of pupils as lesson progresses the method of delivery of the lecture could be varied and changed to suit the needs.

Precautions

1. All the aids must be arranged in the order in which they are to be used, leading to orderly thinking. Fumbling for things will destroy for communion between teachers and pupils.
2. The experiments must be simple and effective and must not take a long time.
3. There must be an element of wonder or surprise associated with the demonstration.
4. The aids must not be arranged mechanically in a straight line.
5. Demonstrations which are simple should be chosen in preference to complicated ones to demonstrate the same aspect.
6. Qualitative experiments should be preferred to quantitative experiments involving time.
7. Control experiments would play a great part to clarify details.
8. When effects are of small magnitude they must be shown on a magnified scale, with suitable aids.
9. Any demonstration made must be with a purpose and the definite objective clearly stated.

10. All the pupils should be able to see the demonstration.
11. Pupils also may be made to assist in the demonstration.
12. Clear and suitable background should be provided for the demonstration set up so that the same could be completely seen by all pupils.

Classroom Interaction

The act of teaching is a kind of reciprocal contact established between the teacher and pupil. This reciprocal contact can be perceived as a series of events which occur one after another. Classroom interaction refers to these chain of events, each one of which occupies a small sequent of time.

An event may be defined as the shortest possible act that a trained observer can observe and record. In a normal class, the same sequence of events occurs again and again. Such a sequence may be called a pattern. Various techniques are used for studying the chain of classroom events. An observer sits in the classroom and keeps a record of the flow of events on an observation form. He is trained to use a set of categories. An analysis can be made of the frequency of each category and a profile of the distribution can be drawn. A single display will show how each event is a part of the chain.

Teacher's Behaviour and Classroom Interaction

Teaching behaviour is an act of the teacher which occurs in the context of classroom interaction. Teachers behave in different ways and, therefore, there are different types of classroom interactions. Some teachers are very strict and some are very kind and lenient. Some are witty and humorous and some are dull. There are some who are very stern and serious all the time. Certainly the teacher's behaviour pattern sets the pattern of pupil behaviour in a classroom. The teacher's behaviour tends to create an atmosphere which we describe as *classroom climate*.

We may classify the teachers's classroom behaviour into two categories—dominative and integrative. When a teacher talks, commands, restricts pupils' freedom to talk, he is dominative. When he allows pupils to talk, ask questions, accepts their ideas and stimulate their participation in class activities, he is integrative. It is therefore the teacher's behaviour which sets the pattern for learning atmosphere or climate in the classroom. If he is generally dominant he promotes such a climate in the class. If he is generally integrative, he aids in integrative climate.

Techniques of interaction analysis have been helpful in the analysis of teaching behaviour. Although only a small proportion of verbal communication is recorded, it is possible to infer about classroom events. It is possible to estimate the initiation and response on the part of the teacher and pupils and a number of other interesting features of teacher-pupil relationships.

Interaction Analysis

Interaction analysis is a process of encoding and decoding the study pattern of teaching and learning. In the coding process, categories for classifying statements are established, a code symbol is assigned to each category and a trained observer records by jotting down code symbols. In the decoding step, a trained analyst interprets the display of coded data and reconstruct the original events on the basis of the encoded data even though he may not have been present when the data were collected. Although there are many systems for coding spontaneous verbal communication in classroom, a typical system for interaction analysis will usually include,

(a) a set of categories, each defined clearly,

(b) a procedure for observation and a set of ground rules which govern the coding process,

(c) steps for tabulating data in order to arrange a display, and

(d) suggestions which can be followed in some of the more common applications.

Classroom interaction analysis can be used for inservice and preservice education in order to help teachers improve classroom instructions. This requires some kind of objective feedback to the person who is trying to change his behaviour.

Classroom Interaction Technique

Study of classrooms had always been deserving the attention of research workers and as a result, it was in late 1930's they became interested in analysing classroom interaction. One of the earliest approaches to the analysis of teaching behaviour was that used by H.H. Anderson. He was interested in developing a reliable technique for the "measurement of domination and of socially integrative behaviour in teacher's contacts with children."

Although classroom observation has been there in our training programme for a long time now, objective and reliable scales of observation are of recent origin. Traditional observation relied on subjective estimates and could not be quantified. The observational scales should not only serve the purpose of observation but should also have mechanical devices against subjective examination by the observers. Let us discuss some of the popular observation schedules that were developed over the past few years.

Observation Schedule and Record (OSCAR)

Medley and Mitzel (1963) developed the *Observation Schedule and Record* (OSCAR) which is both a 'Sign and Category' system designed to facilitate observational study of teacher graduates. The scales have been derived from factor analysis and the items have been empirically tested. Both verbal and non-verbal phenomena are observed and analysed with this system.

In this 'combined checklist and category system', items included are the following :

Teacher categories

1. Teacher lectures;
2. Teacher reads, tells story;
3. Teacher talks to class;
4. Teacher illustrates.

Pupil categories

1. Pupil talks to group;
2. Pupil reads aloud;
3. Pupil sings, plays instrument;
4. Pupil plays game;
5. Pupil scuffles, fidgets;
6. Pupil whispers;
7. Pupil laughs;
8. Pupil talks to visitor, etc.

Non-verbal categories

1. Use of blackboard;
2. Use of slides, film;
3. Special teaching aids, etc.

The system is designed to increase observer accuracy by reducing the difficulty of the judgments required; the process of scoring is separated from that of observing teacher behaviour.

Very detailed observation cards are used for observing and recording teacher behaviour in this system.

Bale's Interaction Process Categories

Bale (1950) developed this category system with the object of studying individual behaviour in selected social and psychological settings. The interaction is either recorded for subsequent analysis or observed and codified in a time-based process.

This is a widely used system of observation, originally developed with the intention of providing a method of analysing the behaviour of small work groups. It has, however, come to be used in instructional settings since it has categories appropriate to describe the behaviour of a teacher or pupils in a classroom.

Every act of the group members is recorded in one of the twelve categories.

1. shows solidarity, raises other's status, gives help, reward,
2. tension release, jokes, laughs, shows satisfaction,
3. agrees, shows passive acceptance, understands, concurs, competes, belongs to social-emotional area-positive reaction,
4. gives suggestion, direction, implying autonomy for others,
5. gives opinion, evolution, analysis, expresses feeling,
6. gives orientation, information, repetition, confirmation,
7. asks orientation, information,
8. asks opinion, evaluation, analysis, expressions of feeling,
9. asks for suggestions, direction, possible way of action,
10. disagrees, shows positive rejection, formality,
11. shows tension, asks for help, withdraws out of field,
12. shows antagonisms, deflates other's status, defends,

Categories 1 and 12 belong to problem of orientation, categories 2 and 11 belong to problems of evaluation; categories 3 and 10 belong to problem of control; categories 4 and 9 belong to problems of decision; categories 5 and 8 belong to problems of tension management; and categories 6 and 7 belong to problems of integration.

Flanders' System of Interaction Analysis

Of all the techniques of interaction analysis mentioned above in connection with their respective studies Ned A. Flanders system (Flanders and Amidon—1963) is easy to handle and can be used as a feedback technique in teacher training. The Flanders system is an observational tool used to classify the verbal behaviour of teachers and pupils as they interact in the classroom. Flanders' instrument was designed for observing only the verbal communication in the classroom and non-verbal gestures are not taken into account. The basic assumption of the system is that in the classroom the verbal statements of a teacher are consistent with his non-verbal gestures, or rather his total behaviour.

FLANDERS' INTERACTION ANALYSIS CATEGORIES (FIAC)

			Category Number	*Activity*
Teacher Talk	Indirect influence	Response	1.	*Accepts feeling* : Accepts and clarifies an attitude or the feeling tone of a pupil in a non-threatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included.
			2.	*Praises or encourages* : Praises or encourages pupil action or behaviour. Jokes that release tension, but not at the expense of another individual; nodding head, or saying "Um hm ?" or "go on" are included.
			3.	*Accepts or uses ideas of pupils* : Clarifying building or developing ideas suggested by a pupil. Teacher extensions of pupil ideas are included but as the teacher brings more of his own ideas into play, shift to category five.
			4.	*Asks questions* : Asking a question about content or procedure, based on teacher ideas, with the intent that a pupil will answer.

(Contd.)

		Category Number	*Activity*
Direct influence	Initiation	5.	*Lecturing* : Giving facts or opinions about content or procedures; expressing his own ideas, giving his own explanation, or citing an authority other than a pupil.
		6.	*Giving directions* : Directions, commands or orders to which a pupil is expected to comply.
		7.	*Criticising or justifying authority* : Statements intended to change pupil behaviour from non-acceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing; extreme self-reference.
Pupil Talk	Response	8.	*Pupil-talk response* : Talk by pupils in response to teacher. Teacher initiates the contact or solicits pupil statement or structure the situation. Freedom to express own ideas is limited.
	Initiation	9.	*Pupil-talk initiation* : Talk by students which they initiate.
Silence		10.	*Silence or confusion* : Pauses, short periods of confusion in which communication cannot be understood by the observer.

Flanders has categorised the interaction of teachers and pupils in classrooms. There are ten categories in the system.

Thus out of the ten categories in the system evolved by Ned A. Flanders, seven categories are assigned to teacher talk and two to student talk and the tenth category classifies pauses, short periods of silence and talk that is confusing or noisy. The seven categories assigned to teacher talk are again divided into indirect and direct influence. Categories 1 to 4 represent influence and categories 5 to 7 represent direct influence. Indirect influence encourages student participation and freedom of action. Direct influence increases the active control of the teacher and often aims at conformity and compliance. Direct influence tends to increase the teacher's activity and restrains student behaviour. The net effect is less freedom of action for the students.

The division of student talk into categories 8 and 9 provides a clue to the nature of freedom given to the students. Usually, but not necessarily, an excessive or above average pattern of direct teacher influence is associated with less student talk. An above average indirect pattern is associated with more student talk and this will be of self initiated type. The use of only two categories to record all kinds of student talk neglects a great deal of information but the major purpose of this system is the analysis of teacher influence.

The purpose of category 10 is to record pauses, silence and periods of confusion. This is not intended to record longer periods of silence or confusion that exists for more than two minutes.

The major feature of this category system lies in the analysis of initiative and response which is a characteristic of interaction between individuals. To initiate means to make the first move, to lead, to begin, to introduce an idea or concept for the first time and to express one's own will. "To respond means to take action after an initiation, to counter, to amplify or react to ideas which have already been expressed, to conform or even to comply to the will expressed by others." Normally it is expected that the teacher should show more initiative than the pupils. With this ten-category system, it is possible to estimate the percentage of time of teacher talk, pupil talk and silence or confusion. An inference can be drawn from this estimate regarding the balance between initiative and response. With seven categories of teacher talk and only two of pupil talk, more information is brought about the teacher. Hence with this particular set of categories, it is possible to study the influence of the teacher statements only.

Observation Procedure

The observer sits in the classroom in the best position to hear and see the participants. At the end of each 3 second period, he decides the category that best represents the communication of events just completed. He writes down this category number while simultaneously assessing communication in the next period. He continues at the rate of 20 to 25 observations per minute, keeping his tempo as steady as possible. His notes are merely a sequence of numbers written in a column, top to bottom, so that the original sequence of events is preserved. Occasionally marginal notes are used to explain the class formation or any unusual circumstances. When there is a major change in class formation, the communication pattern or the subject under discussion, a double line is drawn and the time is indicated. As soon as the total observation is completed, he retires to a room and completes a general description on each separate activity period indicated by the double lines.

Ground Rules to be Observed : Before proceeding to observe the class and mark the observations in a coding chart, it is necessary to establish certain ground rules which become conventions for coding. Since classroom interaction is so complex, category definitions, ground rules and their explanations can never completely cover all the classification problems that will arise. However the following ground rules are helpful to decide the proper categorisation of the interactive behaviours when the observer is faced with some difficulty.

1. When not certain in which of the two or more categories a statement belongs, choose the category that is numerically farther from the category five, with the exception of category ten.
2. If more than one category occurs during the three second interval, then all categories used in that interval are recorded. If no change occurs within three seconds, repeat that category numbers.
3. When the teacher calls on a child by name, the observer ordinarily records as 4.
4. If there is discernible period of silence, record one 10 for every 3 seconds of silence, laughter, board work, etc.
5. When the teacher repeats a student's answer and if it is a correct answer, this is recorded as a 2. This tells the student that he has the right answer and therefore functions as praise.
6. Statements such as '*uh huh*, yes, all right, okay' which occur between two 9's are recorded as 2.
7. A teacher's joke which is not made at the expense of the children is a 2. If the joke makes fun of a child, then it is coded as a 7.

8. An 8 is recorded when several students respond in union to a narrow question.

Recording of Observations in the Coding Chart

A trained observer records his data as a series of numbers. Let us consider the following episode and try to analyse it into various categories, by indicating the relevant code numbers.

Teacher :	Boys ! May I have your attention please.	6
During the next 3 seconds, talking and noise diminish.		10
Teacher :	Today we are going to study the properties of magnets.	5
	I am sure, you will find the lesson very interesting	1
	Has anyone of you seen a magnet ?	4
Pupil :	I have seen one, Sir.	8
	My father brought it from a shop. It attracts a piece of iron.	8
Teacher :	Good. You have a wonderful sense of observation.	2
	As Ramu said, a magnet attracts iron.	3
	The teacher shows a magnet, brings it near iron filings.	
Teacher :	All of you observe carefully.	6
	Krishna ! What do you see here ?	4
Krishna :	The magnet attracts iron filings, Sir.	8
Govinda :	Will the magnet attract all kinds of objects, Sir ?	9
Teacher :	Sit down. Do not ask silly questions in the middle of the discussion.	7

By now, the observer has written down the code numbers beginning from 6 as follows : 6, 10, 5, 1, 4, 8, 8, 2, 3, 6, 4, 8, 9, 7.

Tabulating a Matrix

To tabulate these observations in a 10 into 10 matrix, the first step is to make sure that the entire series begin and end with the same number. The convention is to add 10 to the beginning and end of the series, unless 10 is already present. So our earlier series now become 10, 6, 10, 5, 1, 4, 8, 8, 2, 3, 6, 4, 8, 9, 7, 10. The observations are now entered in a 10 x 10 matrix so that the sum of column one equals the sum of row one, the sum of column 2 equals the sum of row 2, etc. The numbers are tallied in the matrix one pair at a time. The column is used for the second number and the row is used for the first number. The first pair in this case is 10-6; the tally is placed in the row 10, column 6 cell. The second pair is 6-10, tally this in the row 6, column 10 cell; the third pair is 10-5; the fourth pair is 5-1; and so on. Each pair overlaps with the next and the total number of observations 'N' always will be tabulated by N-1 tallies in the matrix. In this case, we started a series of sixteen numbers and the series produce 15 tallies in the matrix as shown below.

	1	2	3	4	5	6	7	8	9	10	TOTAL
1				I							1
2		I									1
3						I					1
4								II			2
5	I										1
6				I						I	2
7										I	1
8		I						I	I		3
9							I				1
10					I	I					2
TOTAL	1	1	1	2	1	2	1	3	1	2	15

Interpreting the matrix : No classroom interaction can be ever recreated. It is part of a moment in history. The purpose of interaction analysis is to preserve selected aspects of interaction through observation, encoding, tabulation and then decoding. Although several inferences can be drawn from the matrix, let us discuss a few of them here.

The proportion of teacher talk, pupil talk, and silence or confusion: The proportion of tallies in columns 1, 2, 3, 4, 5, 6, and 7, columns 8, 9 and column 10 to the total tallies indicates how much the teacher talks, the student talks and the time spent in silence or confusion. After several years of observing, we anticipate an average of 68% teacher talk, 20% of pupil talk and 11 or 12% silence or confusion.

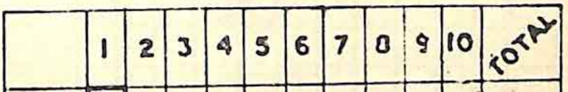
2. *The ratio between indirect influence and direct influence (i/d ratio) :* The sum of column 1, 2, 3, 4 if divided by the sum of columns 5, 6, 7 gives this ratio. If the ratio is 1 or more than 1,

the teacher is said to be indirect in his behaviour. This ratio, therefore, shows whether a teacher is more direct or indirect in his teaching.

3. *The ratio between positive reinforcement and negative reinforcement (i/d ratio) :* The sum of column 1, 2, 3 is to be divided by the sum of the columns 6, 7. If the ratio is more than 1 then the teacher is said to be good.

4. *Student's participation ratio :* The sum of columns 8 and 9 is to be divided by the total sum. The answer will reveal how much the students have participated in the teaching-learning process.

5. *Steady state cells :* The following figure shows the 'steady state' cells along the diagonal from the upper left to the lower right. If these cells are heavily loaded, it shows that the teacher remains in a particular category for more than three seconds.

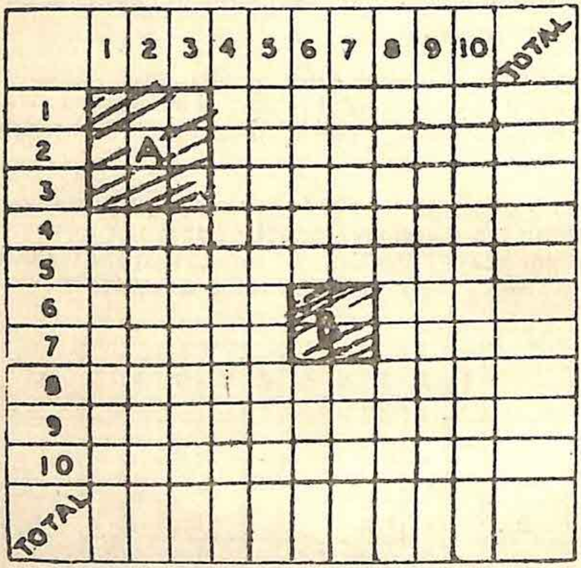


	1	2	3	4	5	6	7	8	9	10	TOTAL
1	1-1										
2		2-2									
3			3-3								
4				4-4							
5					5-5						
6						6-6					
7							7-7				
8								8-8			
9									9-9		
10										10-10	
TOTAL											

The cell with the highest frequency of the entire matrix is typically the 5-5 cell which lies on this diagonal indicating that the teacher frequently stays longer than 3 seconds when he provides information through lecture.

6. *Content cross cells :* The cells corresponding to the numbers 4 and 5 in the column and the row are known as 'content cross cells. If these cells are overloaded they reflect the teacher's emphasis on the subject-matter.

7. *Constructive integration cells and vicious cells :* Two areas that are most sensitive to the positive and negative aspects of social skill is the teacher-student relationship. This is shown in the following figure.



Area *A* might be called "Constructive Integrative Cells" while area *B* is called the "Vicious Cells". The cells corresponding to numbers 1, 2 and 3 are known as constructive integration cells. Cells of numbers 6 and 7 are known as vicious cells. These cells reveal the teacher's attention to problems of classroom management and control as distinct from concern with the subject-matter.

Advantages of FIAC

Ned Flanders technique of Interaction Analysis is a boon for observing student-teachers. As Dr M.B. Buch says, it is "a bold step in the right direction to improve the quality of education". Several advantages are claimed for this method of analysis. The following are a few among them.

(a) The analysis of matrix is so dependable that even a person not present when observations were made, could make accurate inferences about the verbal communication and can get a mental picture of the classroom interaction.

(b) Different matrices can be made and used to compare the behaviour of teachers at different age levels, sex, subject-matter, etc.

(c) This analysis would serve as a vital feedback to the teacher or teacher trainee about his intentions and actual behaviour in the classroom. The supervising or inspecting staff can also easily follow this system.

(d) It is an effective diagnostic tool to measure the social-emotional climate in the classroom.

Verbal Interaction Category System (VICS)

The Verbal Interaction Category System (VICS) developed by Amidon and Hunter (1967) is an extension of Flanders' System of ten categories. It contains five major categories for analysing classroom verbal behaviour as follows:

I. TEACHER INITIATED TALK

1. Gives information or opinion
2. Gives direction
3. Asks narrow questions
4. Asks broad questions

II. TEACHER RESPONSE

5. Accepts
    - Ideas
    - Behaviour
    - Feeling
6. Rejects
    - Ideas
    - Behaviour
    - Feeling

III. PUPIL RESPONSE

7. Responds to teacher
    - Predictably
    - Unpredictably
8. Responds to another pupil

IV. PUPIL INITIATED TALK

9. Initiates talk to teacher
10. Initiates talk to another pupil

V. OTHER

11. Silence
12. Confusion

As in the FIAC a category is tallied every three seconds, in sequence, in columns. The pace of recording is thus the same as in the FIAS. Finally, however, the VICS observations are entered in a seventeen row by seventeen column matrix for summary, review and reconstruction of the verbal phenomenon observed.

As in the FIAS, the VICS matrix too has certain significant areas, where the relatively heavy tally concentrations occurring would refer to unusual aspects in the verbal communication.

Reciprocal Category System : (RCS)

Richard Ober of the University of Florida has put forward a modified adaptation of the FIAS known as the *Reciprocal Category System* (RCS). In this there are nine categories which are applicable to either teacher or the student in a reciprocal manner and a tenth category of Silence or Confusion. The nine categories are, warms (informalises classroom procedure), accepts, amplifies, elicits, responds, initiates, directs, corrects and cools (makes the classroom climate easy and formal). The RCS, therefore, not only enables us to determine the nature and type of teacher-pupil interaction but also to estimate the socio-emotional climate in the classroom by noting the warming and cooling behaviour of teachers.

Equivalent Talk Categories (ETC)

In 1970, E.L. Bentley and E. Milber developed the Equivalent Talk Categories (ETC) which are ten in number and which emphasise the type and degree of intellectual exchange between the teacher and his pupils enabling us to determine the available opportunities for pupils to thank and to infer in the classroom. This appears to be of rather limited value.

Whatever system we may use, we should remember that the validity of our interpretation depends upon the accuracy of our observation and training of observers is therefore quite important.

Micro-Teaching

There has been a growing concern among educational thinkers for reshaping teacher education programmes so as to make it more effective, meaningful and scientific. The method of approach for training in teaching at present adopted in training institutions leaves much to be desired. There is no consensus regarding the procedures followed in various aspects of student teaching and assessment of teacher behaviour. The teacher educators are not clear about the specific objectives of training programme. Supervision of practice teaching is haphazard and mostly unreliable. There is no organised form of feedback regarding the performance of the teacher in the classroom.

The suggestions offered by the teacher educators are mostly subjective and based on general impressions; the defects are not actually pinpointed. Hence some other effective technique or approach should be adopted for developing the various teaching skills among teachers. In this context, micro-teaching which is one of the recent innovations comes as a remedy to the above problem.

What is Micro-teaching?

Micro-teaching technique was first adopted at Stanford University, U.S.A. in 1961 by Dwight W. Allen and his co-workers and is now followed in many countries with modified and improved techniques. Micro-teaching is now considered not only as a constructive teacher training technique but also as "a versatile research tool which dramatically simplifies the logistics of investigating certain teaching skills and learning variables."

Teaching constitutes a number of verbal and non-verbal acts. A set of related behaviours or teaching acts aiming at specific objectives and performed with an intention to facilitate pupils' learning can be called a teaching skill. All these teaching skills which go to make good teaching can be defined, observed, measured and controlled by means of practice. Micro-teaching concentrates on specific teaching behaviours and provides opportunity for practising teaching under controlled conditions.

Micro-teaching is a scaled down sample of teaching. Just as a driver will not give his first lessons to a learner on a highway where there is continuous flow of traffic, so also a teacher trainee should not be exposed to a real situation even in the beginning. He should teach in a less risky situation where mistakes may be made without damage to pupils and to himself. The complex act of teaching should be broken down into simple components making the task more manageable. Only one particular skill is attempted and developed during micro-teaching session. *How to teach* is considered more important than *what to teach* Micro-teaching not only offers a helpful setting for an inexperienced teacher to acquire new skills but is also equally helpful to more experienced teachers to refine the skills they already possess. It is useful in pre-service as well as in-service training of teachers.

Micro-teaching provides teachers with a practice setting for teaching in which the normal complexities are reduced in terms of

—length of the lesson, (a simple and single concept is only chosen)

—scope of the lesson,

—number of students, usually 5 or 6, preferably peers

—class time, usually 5 or 7 minutes.

Micro-teaching involves a programme of the following type.

1. A particular skill is defined to student teachers in terms of specific teaching behaviours and the objectives which such behaviours aim at achieving.
2. The teacher educator can give a demonstration lesson where the particular skill is employed. Videotape or a film based on the use of the specific skill, if available can also be shown. Or the teacher educator can at least present a prepared 'episode' so as to serve as a model for the trainees.
3. The student teacher then prepares a lesson plan based on the pre-decided model on a suitable topic relating to the particular skill which he proposes to practise. More than the subject-matter, the technique of maximising the use of the behavioural components involved in that skill is considered important in micro-teaching. This is called the *Plan* session.
4. The student teacher *teaches* the lesson to a small group of pupils, preferably of peer group in a simulated condition. The college supervisor or a peer can observe the lesson given by the trainee and can note down their observations in a specially developed proforma. The lesson may be videotaped if facilities exist.
5. *Feedback* is provided immediately to the student teacher by audiotape or videotape recorder. The student observes and analyses his lesson with the help of the supervisor. In the absence of the videotape or audiotape, peers who participated in the lesson as learners, peer observers, the college supervisor can provide the necessary feedback. The observation schedule maintained by the college supervisor and peer group observers can provide useful information for the feedback session. The tallies made in the observation schedule will help the supervisor to make reinforcing comments about instances of effective use of the skill and also situations where the skill could have been more effectively made use of. This session is sometimes called 'critique session'.
6. In the light of the feedback and supervisor's comments, the student teacher *re-plans* or restructures the same lesson or a different lesson in order to use the skill more effectively.
7. The revised lesson is *re-taught* to a different but comparable group of pupils.

8. The lesson is again observed or videotaped or audiotaped and observations are noted in the proformas as was done earlier in the teach session. Feedback is again provided on the reteach lesson. This step is called the *refeedback* session.
9. The *plan*, *teach*, *feedback*, *replan*, *reteach* and *refeedback* sessions will constitute a single micro-teaching cycle. This cycle may be repeated till adequate level of skill acquisition takes place.

Supervisors play an important role in micro-teaching, particularly in preservice training programmes. The role of supervisor is one of continuous consultation so that the trainee can perfect his performance in the particular teaching skill.

According to J.C. Clift, the elements which normally go to make up the micro-teaching procedure may be grouped under three heads: (1) *Knowledge acquisition phase* (observing the demonstration of the skill and analysis and discussion of the demonstration), (2) *Skill acquisition phase* (preparing the micro lesson involving the skill and practising the skill while teaching), and (3) *Transfer phase* (evaluating performance leading to feedback, re-plan and re-teach and transfer of skill to actual class teaching in macro sessions). Micro-teaching is flexible and adaptable to different needs and purposes.

Important Features of Micro-teaching

1. *Micro Element* : Micro-teaching reduces the complexities of the teaching situation in terms of number of students, duration of the lesson and subject-matter to be taught so as to enable the trainee to concentrate on the training process. Training is also given in the mastery of only one skill at a time. One should master the components of the task of teaching before he attempts to perform effectively the complicated task of teaching at macro-level.

2. *Teaching Skills and Teaching Strategies* : Various researchers, both in the West (Allen and Ryan) and in our country (Buch, Passi and others) have listed a wide variety of skills which are representative of the tasks, procedures and strategies involved in teaching many subjects at different levels. The repertoire of skills which have been thought of under the task of teaching may be classified under three heads. The different teaching skills are not necessarily discrete but they can be specifically identified and therefore capable of independent practice.

(i) *Pre-instructional skills :* involving writing of instructional objectives, sequencing and organising knowledge to be presented in order to achieve specific objectives, appropriate content, proper organisation, selection of proper audio-visual aids etc.

(ii) *Instructional skills :* like skills of introducing a lesson, skills of explaining and illustrating, reinforcement, probing questions, reinforcing pupil participation, diagnosing pupil's difficulties etc.

(iii) *Post-instructional skills* : like skills of writing test items, interpreting pupils' performance in a test, planning remedial measures etc.

Micro-teaching enables one to develop these skills and perfect them in such a way as to master the teaching strategies.

3. *The Feedback Element* : In the present system of assessing the teaching competency of the trainees, feedback is given by the supervisor on the basis of his selective note taking and his ability to recall. Overall impression carries greater weight and subjective factors into his system of assessment.

But in micro-teaching, several reliable and authentic sources can be employed for providing necessary feedback.

(i) Oral feedback by the supervising teacher.

(ii) Observation schedules filled in by the peer group participating in the micro lesson.

(iii) Audiotape recording is a source of accurate feedback. But the tape recorder can record only verbal interaction in the class and does not provide the 'whole picture'.

(iv) Videotape recording provides the most accurate and powerful source of feedback. Classroom activities can be recorded with minimum disturbances to teacher and students.

2. *Safe Practice Ground* : A micro-teaching laboratory appears to possess all the inherent features of the real classroom. As teaching is performed under simulated conditions with a small peer group, the teacher trainee does not have any inhibitions.

5. *The Teaching 'Models'* : The trainees have many opportunities to study the desired patterns of behaviour through a tape or film of teaching models or a demonstration given by the supervisor. Using these models as guides, the trainees will develop their own style.

Classification of Teaching Skills

Teaching is a complex process. Teaching is not merely a long lecture impregnated with mass of facts but consists of several purposeful tasks or skills. A teaching skill can be defined as a set of teacher behaviours which are specially effective in bringing about desired changes in pupils. Teaching skills that can be applied at many levels for many subjects have been identified, isolated, collected and classified from a range of sources. Research studies, classroom interaction analysis, observation of classrooms, and various theories of teaching have helped in identifying the skills. The Australian Advisory Committee on Research and Development in Education have analysed teaching into 140 skills. Allen and Ryan of the Stanford University have suggested the following fourteen skills that are representative of general teaching skills.

1. Stimulus variation
2. Set induction
3. Closure
4. Silence and non-verbal cues
5. Reinforcement of student participation
6. Fluency in asking questions
7. Probing questions
8. Higher order questions
9. Divergent questions
10. Recognising attending behaviour
11. Illustrations and use of examples
12. Lecturing
13. Planned repetition
14. Completeness of communication.

Based on the lists of teaching skills developed at Stanford University, the Baroda General Teaching Competence scale (BGTC scale) has developed with emphasis on the development of 21 skills. All the 21 skills have been classified as Pre-instructional, Presentation (Instructional), Closing, Evaluation and Managerial skills. Instructional materials in the form of teachers' hand books have also been developed by them for thirteen of these skills. Dr Passi (1976) has described the following thirteen skills in detail with the components of each in his book *Becoming Better Teacher—Micro-teaching Approach*.

1. Writing instructional objectives
2. Introducing a lesson

3. Fluency in questioning
4. Probing questions
5. Explaining
6. Illustrating with examples
7. Stimulus variation
8. Silence and non-verbal cues
9. Reinforcement
10. Increasing pupil participation
11. Using blackboard
12. Achieving closure
13. Recognising attending behaviour.

Although practising every skill in micro-teaching is very important and necessary for a notice, based on the importance and need, a student teacher may select a few skills and practise them one at a time. The teacher trainee may also select the particular skills in preference to others with reference to his deficiency. The 'component skills approach' emphasises the acquisition of one skill at a time. The trainee must understand the teaching skill to be learnt and its various components that go with it for shaping the behaviours.

Some of the skills which are frequently used in teaching almost all the subjects and are considered to be important from the point of view of teacher training are discussed below with the components of each.

1. *Skill of Stimulus Variation*

Boredom is often a major problem in the classroom and the instructional styles of many teachers do not even recognise this factor. They remain stationary at a place or speak in a monotonous voice throughout. This skill is related to procedures by which the attention of the class can be secured. This involves deliberate changing of various attention-compelling behaviours of the teacher in order to maintain pupils' attention at high level. The behaviours corresponding to the skill can be stated as follows.

(a) *Movements* : Teacher's movement in the class from one place to another facilitates useful shifts for attention. Such movements must be purposeful, for example, movement towards blackboard to discuss a point on the blackboard.

(b) *Gestures* : Movements of head, hands and body for more expressive and dynamic presentation, for example, to express emotion, to indicate sizes, shapes, movements, etc.

(c) *Change in speech pattern* : Sudden or radical change in tone, volume or speed of the teacher's speech, modulation of voice, etc.

(d) *Focussing* : Verbal, gestural or verbal-gestural focussing, calling attention to a specific material as 'listen to this', 'look at this' etc.

(e) *Change in interaction styles* : Instead of teacher monologue, teacher is encouraged to use three patterns of interaction.

Teacher→Group : Teacher making a dialogue with the entire class—whole class answers questions.

Teacher→Student : An individual student is asked probing questions.

Student→Student : One student's response is redirected to another student for comment or clarification.

(f) *Pausing* : Short deliberate intervals of silence used while conveying information, lecturing, explaining.

(g) *Oral-visual switching* : Shifting the sensory channels through which information is conveyed to pupils, i.e., from oral→visual ; oral→oral-visual ; visual→oral-visual.

2. *Skill of Probing Questions*

When the teacher puts a question to the class, he gets various types of responses from the pupils. In such a situation, when correct responses are not given, the teacher should lead the pupils to the correct response without resorting to punishment. The teacher has to go deep into the pupils' responses or probe into them by asking a number of questions about what they already know and to lead them to correct response. Even if the response is correct, the teacher may help the pupils to view it from a broad perspective. Such techniques that deal with the pupil responses to the teacher's questions are included in the skill of reinforcement.

The following are the components of the skill of probing questions:

(a) *Prompting* : Questions where there is a hint for the pupil which helps in reaching expected response.

(b) *Seeking further information* : Questions where more information is sought, asking *how* and *why* of correct or wrong part of the partially correct answer.

(c) *Refocussing questions* : Questions which seek from the pupil to compare the phenomenon with other phenomena for similarity or contrast or for any other relationship.

(d) *Redirected questions* : Questions which are directed to more than one pupil for response.

(e) *Increasing critical awareness :* Questions which require the pupil to rationally justify his response.

3. *Skill of Explaining*

Explanation is a set of interrelated statements made by the teacher related to a phenomenon or an idea in order to increase understanding in the pupils about it. In order to be a good explainer, the teacher trainee has to develop certain desirable behaviours like using explaining links, using beginning and concluding statements, avoiding undesirable behaviours like irrelevant statements, lacking in continuity, using inappropriate vocabulary, lacking in fluency and using vague words and phrases.

4. *Skill of using Blackboard*

Blackboard or chalkboard is one of the most widely used visual aids in a classroom. Very often, it is also one of the misused aids. Many teachers seem to forget the availability of a versatile tool close at hand. The components of the skill of using blackboard are (*a*) writing legibly on the blackboard, using different letters which are large enough to be read by pupils and adequate space in between the letters ; (*b*) neatness in the blackboard work which can be achieved by retaining only the relevant matter under focus and by seeing that there is no overwriting ; and (*c*) appropriateness of written work in respect of meaning, brevity, simplicity and continuity in the points being presented, underlining important words using coloured chalks, developing the necessary and proportionate diagrams along with the lesson.

5. *Skill of Reinforcement*

All pupils in a class need social approval of their behaviours. When they are answering a question, they are eager to know whether their answers are correct or not. When they are appreciated for the correct answers, they are more eager to respond correctly and get teacher's approval. Their participation in the class increases. This is the result of positive reinforcement. On the other hand, if they feel discouraged by the teacher's behaviour, they remain passive. Both positive and negative reinforcements can either be verbal or non-verbal behaviours. The skill has the following components. Using verbal reinforcers, repeating and rephrasing the pupil's answers, using extra-verbal cues like *Um um Aha* to encourage pupils while answering, and writing pupil's answers on the blackboard are positive reinforcers. On the other hand, a teacher should avoid using negative verbal reinforcement, negative non-verbal reinforcement like frowning, staring, and inappropriate use of reinforcement. The teacher trainee must practise using positive reinforcers and avoid the use of negative reinforcers so that pupils participate to the maximum.

Feedback

The success of micro-teaching technique depends upon the type of effective feedback provided to the teacher trainee. The closed circuit television (CCTV) can be an effective instrument for providing the authentic feedback. The short lesson that is given by the trainee may be recorded on a videotape and can be used for the teacher trainee to hear and see the defects for himself. In the absence of CCTV, a tape recorder can be used for recording the verbal behaviours of the teacher. Along with the tape recorder, the non-verbal behaviours may be recorded in the specially prepared observation schedules. Micro-teaching can be practised in the absence of both the CCTV and the audio-tape recorder. Specially prepared questionnaires or observation schedules may be given to the observers for evaluating the specific aspects of the lesson and can be effectively used during critique sessions.

Two types of observation schedules are used, viz., Category type and Rating type. The category type of observation schedule makes note of the frequency of occurrence of each of the behavioural components. This type of schedule is useful for giving pinpointed feedback and in increasing the desirable behaviours and decreasing the undesirable behaviours. The rating type of schedule makes use of ratings on a seven point scale for each of the behavioural components. The results of the rating scale will tell the trainee the direction of improvement in terms of quality. Specific rating schedules relevant to the different teaching skills have been evolved.

Training colleges in other countries and in India which lack sophisticated television facilities have begun to experiment using the techniques of micro-teaching with audio tape recorder or without any special equipment. The principles relating to acquisition of teaching skills are the essential fabric of micro-teaching. Hence the appraisal made on the basis of the schedules can as well provide necessary feedback if they are used carefully and properly.

Integration of Skills

Micro-teaching technique is practised under the premise that teaching has its repertoire of skills and all these skills can be practised separately, one at a time. While practising one skill, the aim of the student teacher must be to maximise the use of the particular skill, although some other skills related to it may also have an indirect part in it. In a micro-teaching session, the maximum use of the particular skill alone is emphasised. In some cases, if it is found that proficiency has not been obtained in respect of a few components of the particular skill, reteach may be adopted only for the components of that skill. Hence one should understand that a micro-teaching lesson cannot be assessed for final grades. Further, micro-teaching is never a substitute to teaching practice or a macro-lesson.

Skills practised in isolation have no meaning unless they are integrated in a macro-lesson. Hence when mastery has been attained in various skills, the teacher trainee should be allowed to teach in a real situation. Are these skills learnt in isolation integrated automatically and made use of in the proper balance in a lesson or is a separate training programme necessary for integration of skills is a problem on which research should throw light.

The Role of Supervisor in Micro-teaching

Micro-teaching is to help a student to improve his own teaching. The supervisor is intimately connected with the vital aspects of *modelling*, i.e., the mode of introducing the skill to the student. Modelling may be *perceptual* (displaying the skill to the trainee through demonstration, film or videotape enabling him to imitate) or it may be *symbolic* (telling the trainee by means of written or verbal instructions as to what is expected of him). In early stages, the supervisor needs to be encouraging and supportive. As the student learns to analyse and improve his skills. the supervisor gradually withdraws support but continues to encourage and supply constructive feedback. By the end of the programme, the student should be able to analyse and suggest improvements with no help from the supervisor.

Simulation

Simulation offers opportunities for compensating the trainee for lack of actual time spent in practice teaching. Simulation is a 'controlled representation of reality involving role playing' and a simplified but minimally distorted reflection of the normal class situations. The peers serve as pupils in such simulated micro-teaching sessions. Simulation permits teacher trainees to engage in a variety of problems that may arise, which they may not face in practice teaching. It can provide a variety of school environments to the trainees at practically no cost and offers immediate feedback making it possible to identify cause-effect relationships. Further students' attitude also indicates that they liked to share the experiences with peers rather than with the college supervisor and to have their plus-points appreciated and faults overlooked.

Research and Micro-teaching

Most of the studies in micro-teaching conducted in India show that micro-teaching is feasible and an effective technique in training of teachers, Passi and Shah (1974) have found that micro-teaching, was effective in developing the skills of questioning, reinforcement, silence and non-verbal cues and illustration and use of examples. Singh (1974) showed that micro-teaching was a more effective technique as compared to interaction analysis and conventional approaches regarding modification of teacher behaviour. Several other studies also have conclusively proved that micro-teaching technique was a more effective teachnique for transfer of general teaching competence to classroom teaching than the conventional practice teaching.

Research has also been done to find out the relative effectiveness of various components of micro-teaching such as modelling (perceptual, symbolic or audio tape), feedback (supervisor, peer or audio), and class conditions (real or simulated) etc. It was generally proved that (*i*) the teaching competence of student teachers using perceptual modelling does not differ from those trained under symbolic or audio modelling; (*ii*) the feedback given by peers or college supervisor or self feedback by audiotape had similar effects on development of general teaching competence; and (*iii*) micro-teaching under simulated conditions did not affect the development of general teaching eompetence.

However research in this field is of recent origin in our country. Studies that have been made in this field are sporadic and lack in comprehensiveness. Hence it is difficult to arrive at a wider generalisation.

Conclusion

The analytic approach to teaching is being criticised by some on the ground that teaching cannot be broken down into sub-components as they lose meaning in isolation and teaching is not a combination of those isolated bits. Teaching task is not to produce skills as an end in themselves but as a means to an end. Teaching is not just summation of teaching skills. One may consider that a specific skill is of value in teaching but whether or not it is appropriate to use that skill in the context of a particular lesson has to be decided subjectively by the teacher.

Teaching is an art, involving certain personality and attitudinal factors. It involves certain teaching skills plus certain decision making. The latter constitutes skills such as when to use a particular skill, how much to use, where to use, etc. Such skills may be more difficult to develop as the teacher has to be exposed to a wide range of situations. But they can be developed only when the student teacher is equipped with a repertoire of teaching skills. Training in teaching skills does change and improve performance and hence the emphasis on micro-teaching.

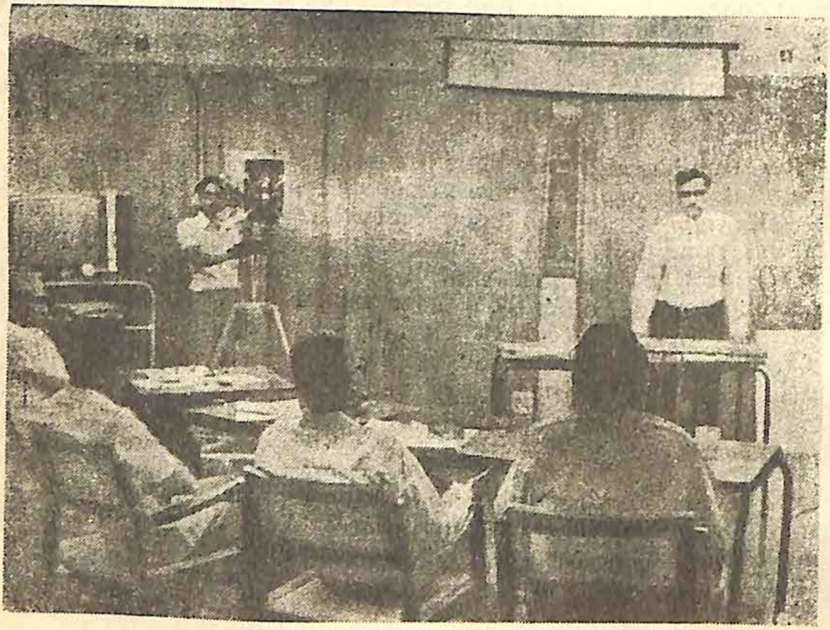


Fig. 3.1
Micro-Teaching Session (Using C.C.T.V.)

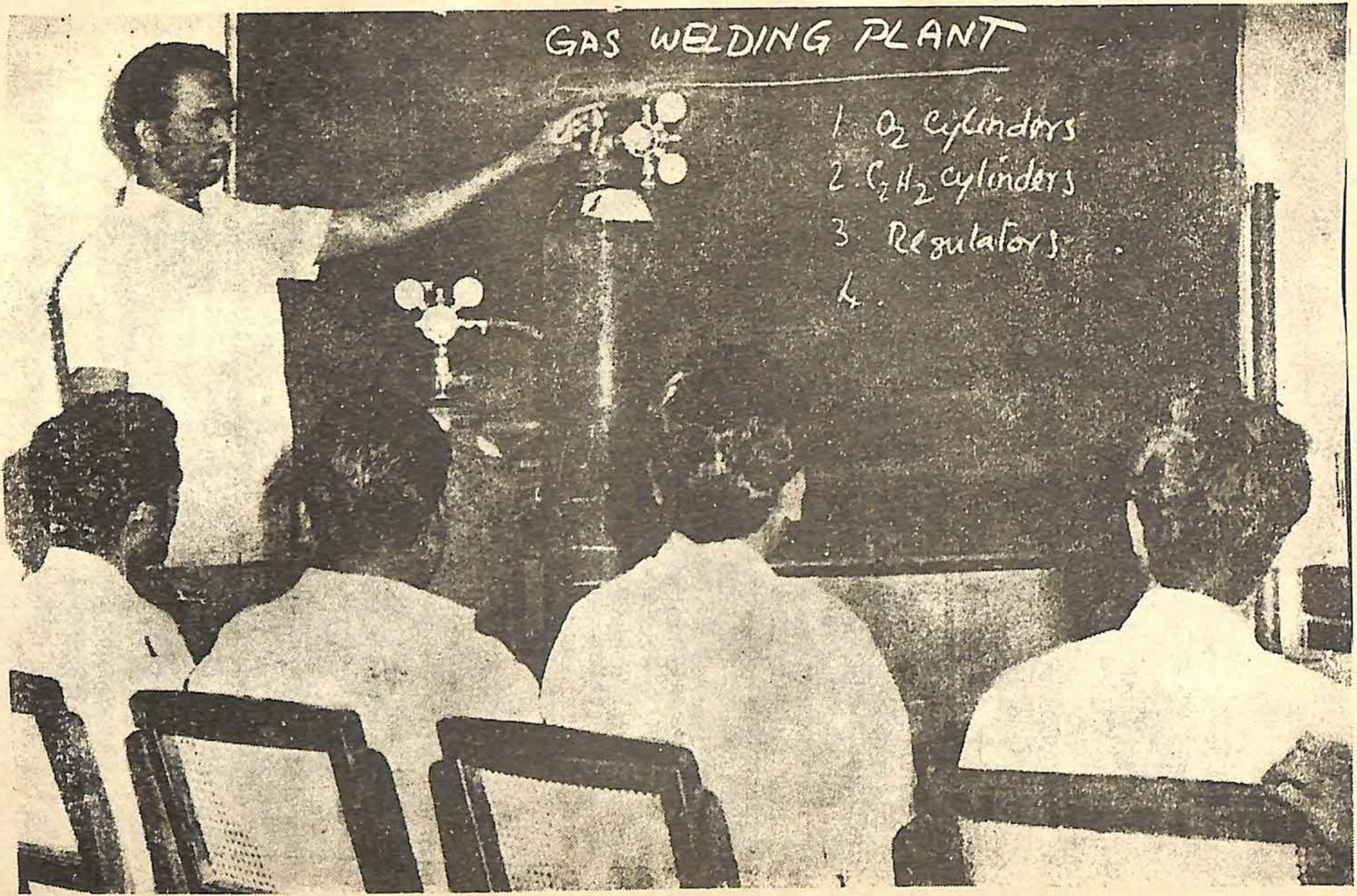


Fig. 3.2
Micro-teaching Session

CHAPTER 4

TEACHING AIDS

Sensory experience forms the foundation for intellectual activity. Sensory aids effect an economy of time in learning. So long, the common practice to communicate knowledge has been by means of written and oral language. But language has many limitations that may contribute to learning difficulty. Generally modern educators recognise in audio-visual materials such basic values as concreteness, enrichment and dynamic interest. The number of aids for teaching has become so numerous that today a teacher of any subject need not resort to any of the archaic methods of teaching. Even the most abstract concept can now be presented to the pupils in a concrete way by means of more than one aid. Some of the distinct advantages claimed for audio-visual aids in helping teachers to arrange more effective environments for learning are discussed below.

General Advantages of using Teaching Aids

The following are the general advantages of using teaching aids:

1. By using audio-visual materials, inaccessible processes, materials, events, objects, changes in time, speed and space could easily be brought to the class. Teachers often face difficulties in making information available to students in certain cases. Students in a large classroom may not be able to see the demonstrations, small models, objects and small pictures shown by the teacher. Further the teacher may not be able to show the microscopic things to the whole class. Sometimes different types of instruction and guidance may be needed for individual students. Audio-visual aids can help the imaginative teacher to solve all these communication problems. Motion pictures using remotely controlled cameras employing slow motion and time-lapse photography techniques, technical animation, etc., closed circuit television equipment, slide-tape presentations and the like can always be used to advantage. Audio-visual aids help to extend human experience.

2. Use of audio-visual materials results in greater acquisition of

knowledge of facts and ensures longer retention of the information gained. Audio-visual materials provide first-hand experiences in a variety of ways and sometimes make the pupils actively participate. Hence they not only help to develop meaningful vocabulary but also enable the pupils remember facts for a pretty long time. Audio-visual technology provides pupils with meaningful sources of experience, primary visual sources as well as additional resources.

3. *Use of audio-visual materials in the classroom can provide effective substitutes for direct contact of students with environment—social and physical.* Audio-visual materials enable us to cut through the physical limits of time and space. A teacher may *take* his class by means of an appropriate motion picture to any distant place and to 'meet' the people who live there and to observe places and things. Some media may serve as a *magic carpet* for providing needed experiences. Motion pictures, television and carefully prepared slide sequences would be particularly valuable. These stimulate pupil interests.

4. Using suitable audio-visual materials, any expected change in attitude and behaviour could be facilitated. Audio-visual materials generally add an interest and involvement to the lesson. Students learn more if they are engaged in significant and appealing activities. Active participation maintains interest and increases learning whether they are participating in individual or group activities like a project. The entire gamut of the audio-visual technology offers much scope for making models and exhibits, writing and producing plays and making charts, diagrams, maps and posters.

5. Proper audio-visual materials can provide integrated experiences varying from abstract to concrete. Audio-visual materials supply a concrete basis for conceptual thinking, giving rise to meaningful concepts. Audio-visual technology presents abstract information to the learners in various forms. On many occasions, teachers have to prepare the students for experiences which are normally beyond the scope of their comprehension. Teachers in this complex age should be able to guide them to the vast reservoir of knowledge by making use of additional resources like television, films, diagrams, charts, globes, maps and transparencies. All these resources enhance clarity of communication and increase speed of comprehension.

6. Using audio-visual materials the approach is through more than one sense—multi sensory approach and hence they will be able to secure and retain the attention of pupils as well as develop the communication skills of pupils.

7. Audio-visual materials could be used to motivate and stimulate interest of pupils to gain further knowledge. Interest is not an

end in itself. Interest that has been created by means of an audio-visual aid must act as a springboard for launching the students into a wide variety of learning activities. Audio-visual media can develop an awareness of problems, open up possibilities for exploration, present meaningful preliminary information and thus open avenues to new activity. A field trip or community study can open up a number of possibilities for further activities like interviewing people, observations, taking photographs of objects seen and then returning to the school to arrange the materials for presentation.

8. Lastly, audio-visual materials could be used to advantage for any age or ability groups. In a conventional teaching method, the teacher is the centre of attention and the primary source of information. Audio-visual media may be used as "supplements" to illustrate, to clarify and to focus attention. When properly programmed, media alone can teach. Students can learn using media at their own pace. For example, the computer-assisted instruction can provide individualised instruction. The particular student using the programme receives immediate confirmation or correction of responses made by him. Similarly the programmed instruction and teaching machines offer lot of possibilities for individualised instruction. Such auto-instructional aids may also make use of tape recordings, slides, filmstrips, motion picture films, models and other media. In brief educational technology helps to multiply teacher efficiency and helps in remedial teaching too. When the audio-visual aids are used it is necessary to make sure that the entire class pupils are able to perceive any specific aspect pointed out by the teacher at the same instant. Hence the aid should be large enough to be seen by all. This fact should be remembered when using the chalkboard and graphic aids. One advantage of using projected aids is the resulting high magnification of the image formed on the screen which is easily seen by all.

Broad Classification of Teaching Aids

Audio-visual technology refers to the systematic use of a category of instructional materials. All the teaching aids can be broadly categorised under two heads, viz., projected and non-projected.

Hardware and Software in Teaching Aids

Educationists categorise the concept of educational technology into two approaches, viz., the hardware approach and the software approach. The *hardware approach* is based on the application of engineering principles for developing electro-mechanical equipments for instructional purposes. Motion pictures, tape recorders, television teaching machines, computers are called educational hardware. This approach is the result of the impact of scientific and technological

Projected Aids	*Non-Projected Aids*				
Films	*Graphic Aids*	*Display Boards*	*3-D Aids*	*Audio-Aids*	*Activity Aids*
Filmstrips	Photographs	Blackboard	Models	Radio	Experimentation
Slides	Pictures	Flannel Board	Objects	Television	
Opaque Projection	Flash Cards	Bulletin Board	Specimens	Recordings	Field Trips
Overhead Projection	Posters	Magnetic Board	Mock-ups		Demonstrations
	Charts	Peg Board	Dioramas		
	Diagrams		Puppets		Dramatics
	Maps				Programmed Instruction
	Graphs				
	Cartoons				Teaching Machines
	Comics				Computer Assisted Instruction

development during the present century. Hardware approach mechanises the process of teaching so that teachers would be able to deal with more students with less expenditure in educating them. The *software approach* uses the principles of psychology for building in the learner a complex repertory of knowledge or modifying his behaviour. It originates from the pioneering work of Skinner and other behaviourists. The programmes which such a technology produces are often called 'software' Newspapers, books, magazines, educational games, flash cards may also form part of software. Software approach is characterised by task analysis, writing precise objectives, selection of appropriate learning strategies, immediate reinforcement of responses and constant evaluation.

Instructional Media

Instructional media are the electromechanical devices which act as middle conditions between student and what he is to learn. An *instructional medium* is simply a means of transmitting instruction. It serves as the channel of instruction. What passes through the channel is the substance of instruction. A distinction can be made between traditional and more recently developed media. Both types make vital contributions to the instructional process. Models, mock-ups; graphic materials namely maps, graphs, charts, diagrams; motion pictures; projected still pictures; opaque projection materials and magnetic tapes are called traditional media. Television which can also make use of traditional media like demonstration with slides, models, transparencies and teaching machines including computerised assisted instruction form the new media. Recently Instructional Kits or 'packages' are developed which contain a variety of carefully related materials including objects, models, motion pictures, filmstrips, tape recordings, student leaflets, programmed materials and workbooks. System analysis and design of instruction are the underlying basic factors in developing these kits.

Multi-media and Instructional Development

Media are best used in combination with a variety of other instructional materials and techniques. Each of these is chosen because of the particular contribution it can make to total learning experience. Media and technology are not the prerogative of the teacher alone. Students can also make use of media for a variety of purposes. Both the teacher and students have become increasingly innovative in devising ways in which they put a variety of media together with other materials and techniques. The experiences may range from visual literacy activities to fairly complex .individualised instruction sequences. There is also an explicit need for a new kind of planning to help assure that our efforts will be successful and effective. This new kind of planning is referred to as 'instructional development'. "Instructional development means application of an instructional systems approach to the analysis and development of practical solutions to the teaching and learning problems."

Technique in using Multi-Media in Instructional Development

The various steps in carrying out interrelated use of media, materials and various teaching and learning strategies to create effective learning experience are discussed below.

1. Define Goals and Desired Terminal Behaviours : The kinds of learning experiences needed for the particular class pupils must be specified in the form of terminal objectives. Instructional development requires well defined organisation, management and scheduling.

2. Plan Materials and Strategies : The instructional materials centre located in the school may have selected filmstrips, pre-recorded tapes, graphics, diagrams, specimens, wall charts, flat pictures, 16 mm and 8 mm films. In addition, the resources of the community may also be available. The materials available may be classified into two categories namely those that can be located by the class members themselves and those that the teacher and school media specialist would arrange to secure. Sometimes materials may be kept in 'packages' in individual containers. The instructional manual for teachers should contain details on : conceptual framework; learning environment; various sub-programmes; learners' goals for each element; entry and exit behaviour; learning procedure and record-keeping. The teacher and pupils should select a variety of communication media for conveying information suitable to each learner.

3. Teaching Strategies and Methods : There must be enough pupil activities. They must present new information through terminal reports, demonstrations, exhibits or evidence. This is the stage at which we are concerned with media along with other materials. The particular advantages of the various media in satisfying the needs of the learner in the specific learning situation must be analysed. By using any number of learning experiences, the learner is helped to conceptualise, to understand, to become involved and to respond with performances.

4. Evaluation and Recycling : Students present reports and teacher evaluates them by reviewing the apparent usefulness to pupils of the newly found materials. The least effective methods are recycled out and better materials are incorporated.

An example of Multi-media Instructional Development

Unit : *India achieves independence*

(a) *Planning :* By a committee of teachers and representatives from various participating group of students.

(b) *Formulation of broad objectives.*

(c) *Selection of learning material :* An examination and evaluation of all available bibliography of media learning material will indicate those relevant to the realisation of the objectives. 16 mm sound motion picture films, filmstrips, tapes, records, flat pictures, etc., comprising multi-media kit is to be built up.

(d) *Selection of teaching methods and strategies :* Deciding which of these objectives could be reached effectively by various teaching modes, as large group/small group talks and discussions, individual work, use of the different media selected, visits by pupils to places of importance, visitors from the community projects, etc.

(e) *Evaluation* : of the completed learning experience, with reference to the reporting of individuals and groups.

Any realistic and comprehensive application of multi-media instructional development should imply flexible or open scheduling and availability of many learning resource materials all readily accessible to pupils who wish to take advantage of small group of independent questing opportunities. The teacher should also realise that some students may be very casual of the whole thing, just putting in time, enjoying the whole 'show' without contributing or working. It has also to be mentioned that some researchers have questioned the value of multi-media and multi-image projection for the reason that one perceives only a single channel of information at one time. So it is for the teacher to decide whether to use a single medium or 2 or 3 media at the same time.

Modular Scheduling

This is an effective type of planning and programming of the class schedule. The school day is normally split up into 6 or 7 periods of 40 to 45 minutes duration. But here it is divided into 20 minute time *modules*, about 20 per day. Each pupil is scheduled for participation as a member of a large group, medium-sized group or small group for 50% of his school day. The other 50% is devoted by him to planning his own work at an instructional material centre where he does independent or small group inquiry through such materials as films, 8 mm film loops, filmstrips, tapes, maps, books, etc., at the same time arranging for participation in other school activities as well as seeking free time for individual discussions with the teacher or getting needed guidance from him. The teachers also plan their time according to modules. This planning will vary with the subject area but each teacher or group of teachers decide how their school day will be divided between actual instruction of large, medium-sized and small groups, individual guidance and evaluation and also participation in school activities. Sometimes, in relation to learning needs, modules may be longer, combining 2 to 3 twenty minute periods. Such a modular scheduling needs considerable instructional materials and resources and meticulous planning and a departure from the inflexible time table routine found in our schools.

Multi-Media Centre

Media centre is a school in itself as well as a centre which serves a school system. It is also called 'instructional materials centre', 'multi-media library', 'curriculum materials centre', 'instructional or learning resources centre' and provides all necessary materials for both teachers and students. The media centre will house all learning materials and accompanying services putting audio-visual and printed resources under a more favourable, single administrative organisation. It provides easier access for individual and group study. It also provides packets of programmed materials called 'packages' for various study units. The packets include pamphlets, specimens of various kinds, transparencies, recordings, photographs, charts, posters depending on the subject to be taught. Some of the materials that have to be procured from outside can be dialed. The centre needs the services of specialists in behavioural technology for arranging systematic integration of various experiences.

Duties of the Co-ordinator of the Media Centre :

The media specialist is the catalyst who activates the instructional development in the whole school system. His duties may be enumerated as follows :

(a) To assist all teachers in the school in audio-visualising their curriculum.

(b) To arrange in-service workshop in different aspects of instructional technology.

(c) To keep an inventory of community resources—museums, film libraries, other resource centres, etc.

(d) To maintain a library of films, filmstrips and other audio-visual education materials.

(e) To assist teachers in planning, selecting, using, evaluating and developing materials of instruction with special attention to newer media of communication.

(f) To organise a good stock of audio-visual equipments and maintain them in good condition.

(g) To provide training to teachers in the use of all equipments and graphics in the workshop so that they develop competence and confidence. Graphics, charts and other visual materials must as far as possible be produced in the workshop itself.

(h) To be sensitive to all new developments in the field of instructional technology.

Uses and Abuses of Multi-Media

Abuses of Instructional Media :

The really effective classroom use of media comes down to a question of *balance* between the teacher's work and media usage. As already stated, teachers should not adopt the view "let the multi-media do it". One reason for the disenchantment of pupils and teachers with such technological innovations like language laboratory is this fallacy. Without teacher's planning, supervision and follow-up, language laboratory cannot teach any language and will result in waste of money and time. Further, one medium of interest to a child need not interest another. What may fit one area of teaching need not suit another. In choosing media the teacher should be aware of the relative effectiveness of different types of instructional media (like oral presentation, printed material and demonstrations, programmed instruction 3-D objects, flat pictures, recordings, films, TV, etc., to various learning objectives. Learning factual information, learning visual identification, understanding concepts, rules and principles, learning processes and procedures, learning and performing skilled perceptual motor acts and developing desirable attitudes, appreciations and opinions are the different learning objectives.

Use of Media

While using any educational media for teaching in classroom, the teacher has to follow five basic principles which form the 'matrix of learnings'.

1. *Selection of Media* : Teachers should base their selection of proper media bearing in mind the learning objectives and the characteristics of pupils. Permanent learning can take place only when teachers and students identify and write out the objectives and performance criteria. With reference to these objectives, the specific media must be selected. The media centre must provide reference services, preview facilities and immediate access to all kinds of media materials including packages and information about rental or loan of additional media from other sources. While selecting the appropriate materials for group study or individuals, the teacher must also

consider the learners' cultural environment, past experience, physical and emotional make up, needs, attitudes and visual literacy. W.H. Erickson and David H. Curl have formulated the following criteria of selection of media in terms of curriculum factors with reference to specified objectives.

1. Is the content useful and important *to the learner* ?
2. Will it be *interesting* to students ?
3. Is there direct relationship to a *specific objective* or problem-solving activity ?
4. How will the format and presentation treatment affect the organisation and sequence of *learner activities* ?
5. Is the material *authentic*, *typical* and *up-to-date* ?
6. Have facts and concepts been *checked for accuracy* ?
7. Do the content and presentation meet contemporary standards of *good taste* ?
8. If controversial, are both sides given *equal emphasis* ?
9. Is *bias* or *propaganda* evident ? If so, how should students deal with it ?
10. Is *technical quality* satisfactory ? Are images clear ? Narration or dialogue intelligible ?
11. Do content and structure reveal *careful planning* by the producer ?
12. Has the material actually been *validated*, or tested with learners ? If so, under what conditions ? What were the characteristics of the students ?

Mere catalogue description will not help the teacher to choose the appropriate aid. He must examine or *preview* the aid before actually using it.

2. *Readiness* : The use of the media in the classroom must be preceded by the learner's readiness for participating in the experience. The minds of the pupils must be prepared.

3. *Setting the Proper Physical Conditions :* Physical facilities and conditions for using the media must be as far as possible ideal so as to effect economy of time and to ensure active participation of the pupils. Proper seating arrangements, sufficient darkening facilities in the room and facilities for manipulating the different media must be ensured.

4. *Consolidation or Follow-up* : Teachers should guide the

learners in their response to experiences gained. Suitable work sheet may be prepared in the light of the objectives and the experiences gained by them through the use of audio-visual presentation.

5. *Evaluation :* Teachers should continuously evaluate the effectiveness of the media and their techniques. The reference points for valuation of the media and method are the specific learning objectives and performance criteria.

Edgar Dale suggests the following criteria for evaluating the audio-visual materials :

1. Do the materials give a true picture of ideas they present ?
2. Do they contribute meaningful content to the topic under study ?
3. Is the material appropriate for the age, intelligence and experience of the learners ?
4. Is the physical condition of the materials satisfactory ?
5. Is there a teacher's guide available to provide help in effective use of the materials ?
6. Do they make students better thinkers, critical-minded ?
7. Do they tend to improve human relations ?
8. Is the material worth the time, expense and effort involved ?

Educational Technology for Exceptional Children

Each classroom will be equipped with varied learning materials. Through better diagnostic instruments, often of a self-testing character, students will get different treatment of learning experiences and the same methods of teaching and learning will not be prescribed for all.

Gifted Children

The following techniques will be adopted for the gifted pupils.

1. *Enrichment* : This can be accomplished in a variety of ways, namely Horizontal Method in which more assignments at the same level of difficulty can be given or Vertical Method where more advanced work at the same general type is given. Individual study projects, Supplementary reading and writing and development of creative hobbies can also be attempted. For all these, programmed material as well as other materials like filmstrips can be effectively used.

2. *Acceleration :* Programmed material can be used to help children learn the subject-matter of the class which is to be skipped by the gifted children.

3. *Correspondence Course Tutoring:* Again Programmed material will be of much benefit.

4. *Special Classes:* Children can be grouped according to their abilities, and individual attention can be given. The skill and resources of teacher, the nature of the pupil and the learning material should be taken into account in dealing with what type of media should be used and when. Grouping of students on the basis of behavioural objectives will be done in future. Class size will vary according to the objectives sought.

Slow Learners

Greater use of concrete aids, activity methods, direct experiences and auto-instructional methods will very much help this group of children.

Handicapped Children

Blind students can 'read' standard printed material with an OPTACON (Optical Tactile Convertor). The OPTACON consists of a small sophisticated camera and a converter. When the camera is placed upon the printed material, it scans it, while the converter transmits the imprint of each letter to the individual fingers. A blind person using an optacon can read as fast as a sighted person who is under the constraint of reading one letter at a time. Although it is not as fast as Braille or recordings, it can be used with printed material.

For *deaf children* through instructional technology, some new techniques have been developed. One of these methods is the extensive use of O.H.P. both as a means by which the teacher presents words, pictures and concepts to the class and as a means by which class members can communicate to the teacher and the rest of the class. In some programmes, each student in the class is equipped with a projector.

CHAPTER V

SYSTEMS APPROACH

Educational technology makes available a wide range of instructional media at the curriculum planning level. The instructional process has become complex these days because of the shift in technological focus from the classroom to curriculum planning. The number of objectives to be reached as a result of the instructional programme has increased. The amount of material to be taught and the media to be utilised have also enormously increased. The number of students and teachers involved in the total instructional system has also increased by leaps and bounds. In such a situation, there is very great need for a comprehensive and detailed planning. The curriculum should not only specify student *behavioural objectives* but also suggest the *strategies* for helping the students to reach the objectives and *evaluation instruments* to measure their success. This is called the *systems approach*, an operational planning concept, borrowed from the engineering sciences and *cybernetics*, which deals with self regulating and self sustaining systems.

Definition of a system

The Webster's dictionary defines a system as "a regularly interacting or independent group of items forming a unified whole". A system is "a group of objects related or interacting so as to form an unity". It also defines a system as "organised or established procedure," or a methodically arranged set of ideas, principles, methods or procedure". *Systems analysis* essentially is a systematic way of identifying goals of any system and scientifically working out different steps to move towards these goals, suggesting 'models' for application.

The approach in general includes the following steps :

(a) an analysis of the existing situation,
(b) setting up of goals for the desired situation,
(c) defining mechanisms to evaluate the achievements of goals,
(d) generating alternative solutions,

(e) choosing the best possible solution through cost-benefit analysis,

(f) detailing out the design of the system,

(g) outlining the monitoring mechanisms for the system, and

(h) working out for introducing the solution.

Systems approach is a rational, problem-solving method of analysing the educational process and making it more effective. System is the process taken as a whole incorporating all its aspects and parts, namely pupils, teachers, curriculum content, instructional materials, instructional strategy, physical environment and the evaluation of instructional objectives. Hence it may be seen that the purpose of the systems analysis is to get the "best equipment in the best place for the best people at the best time and at the best price." "The systems approach in instruction is an integrated, programmed complex of instructional media, hardware and personnel whose components are structured as a single unit with a schedule of time and sequential phasing."

Components of an Instructional System

Systems approach is a systematic attempt to coordinate all aspects of a problem toward specific objectives. In education, this means planned, organised use of all available learning resources, including audio-visual media, to achieve the desirable learning objectives by the most efficient means possible. The systems approach focusses first upon the learner and the performances required of him. Only then, it makes decisions regarding course content, learning experiences and the most effective media and instructional strategies. Such a system incorporates within itself the capability of providing continuous self correction and improvement. It is concerned with all elements of instruction including media. Its purpose is to insure that the components of the organic whole will be available with the proper characteristics at the proper time to contribute to the total system fulfilling the objectives.

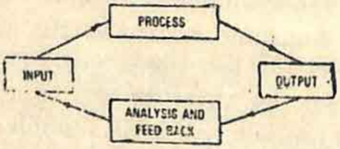
The procedural steps in the systems approach in education are as follows :

1. Defining instructional goals, behavioural objectives and stating them in operational, measurable terms.
2. Determining functions related to the achievements of these goals by proper aids like films, recordings, videotapes, etc.
3. Defining learner characteristics and requirements.
4. Choosing appropriate methods suitable for effective learning of the topic.
5. Selecting appropriate learning experiences from many alternatives available.

6. Selecting appropriate materials, facilities, equipment, resources, environment, tools required for student experiences.
7. Defining and assigning appropriate personal roles—teachers—team teaching members—supporting personnel—students.
8. Implementing the programme—Try with a few pupils in typical and appropriate condition.
9. Testing and evaluating the outcome in terms of original objectives measured in student performance.
10. Refining and revising if necessary to improve production and efficiency of the system to improve student learning.

In an *instructional system*, the teacher or instructor and the resources made use of by him are included as components of the system. There is provision for continuous evaluation and self correction for realising the stated objectives. In the systems approach to instruction, the teacher has to plan completely the utilisation of selected resource material and the classroom activities (each pupil working alone ; small groups of pupils, 4 to 6, working alone or with teacher guidance ; large groups working alone ; very large groups requiring the use of mass communication media). The teacher should have a good overall view of the subject, know his/her limitations, know all about his/her pupils and the individual differences in their learning capacities and plan accordingly. The systems approach involves continuous evaluation of learning outcomes and utilisation of knowledge gained by analysis of results of evaluation to suitably modify the plan of approach to achieve the stated objectives.

In brief the *systems approach applied to educational situations* involves the following interlinked and interdependent stages. (a) Explicitly stated standards of output performances, including sequenced behavioural objectives and post test ; (b) Planned input and processes involving structural learning materials and methods suitably geared to the needs of a particular group of learners ; (c) Monitored output which is used to revise, improve and evaluate the instructional system, providing feedback to the learner and teacher, and (d) A degree of in-built flexibility to adjust to individual situations.



The parts of the instructional system noted above can be analysed into their possible components as follows :

Institutional planning—Application of systems approach—an example.

I. INPUT

Pupils :
- (a) age
- (b) minimum prescribed entry qualifications, attainments (entry behaviour) decided by (i) curriculum content (objectives) (ii) duration of the course.
- (c) Desirable to consider (i) attitude
  (ii) aptitude of pupils

Cost factor which is a constraint on input should also be considered in terms of its benefits.

- (a) Job opportunities after passing out.
- (b) Location of the institute
  - Rural
  - Urban
- (c) Hostel facilities—cost—finance involved

II PROCESS

1. Curriculum
   - need based
   - well-defined objectives—anticipated behavioural changes in pupils
   - Suggested strategy and lines of approach (media, methods)
   - Evaluation procedures laid out

2. Institute (a) Physical environment

   Location
   - Urban Isolated
   - Rural Proximity to living habitat
     Transport

   (b) Buildings, Classrooms etc.
   - adequacy of space
   - well lighted—cross ventilation
   - fixtures and suitable furniture

   Library
   - Books
   - Journals
   - Designed and organised for optimum use
   - well equipped

(c) Facilities	Laboratory workshop	sufficient number of equipments
	Society Service Centre	
	Recreational facilities	
	Hostel facilities for boarding pupils and staff	
	Background	
	Suitable general qualifications	
(d) Teachers	Professional qualification or training	
	Industrial experience	
	Attitude—job satisfaction	

Constraints to get suitable teachers	Finance Location of institution

III FEEDBACK

(a) Evaluation by public organisations, boards, universities	Internal External Part internal and part external performance

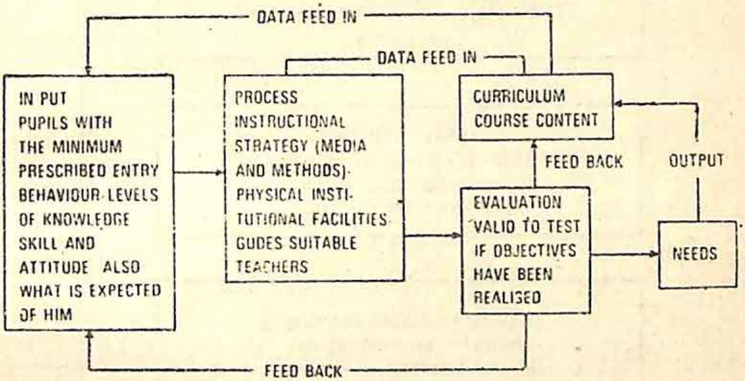
(b) Employees—Initiative—adequacy of knowledge—skill—adaptability and ability to apply knowledge to practical situations.

For maximum effectiveness, it is necessary to consider the system as a whole remembering the interaction and inter-dependence of the components of the systems. Full details and specifications about the interacting factors should be clearly defined. Systems approach in education may be applied to institutional planning and development in its varied aspects (Macro level) or it may be used at the classroom level with its concern of a specified topic during a brief period (Micro level).

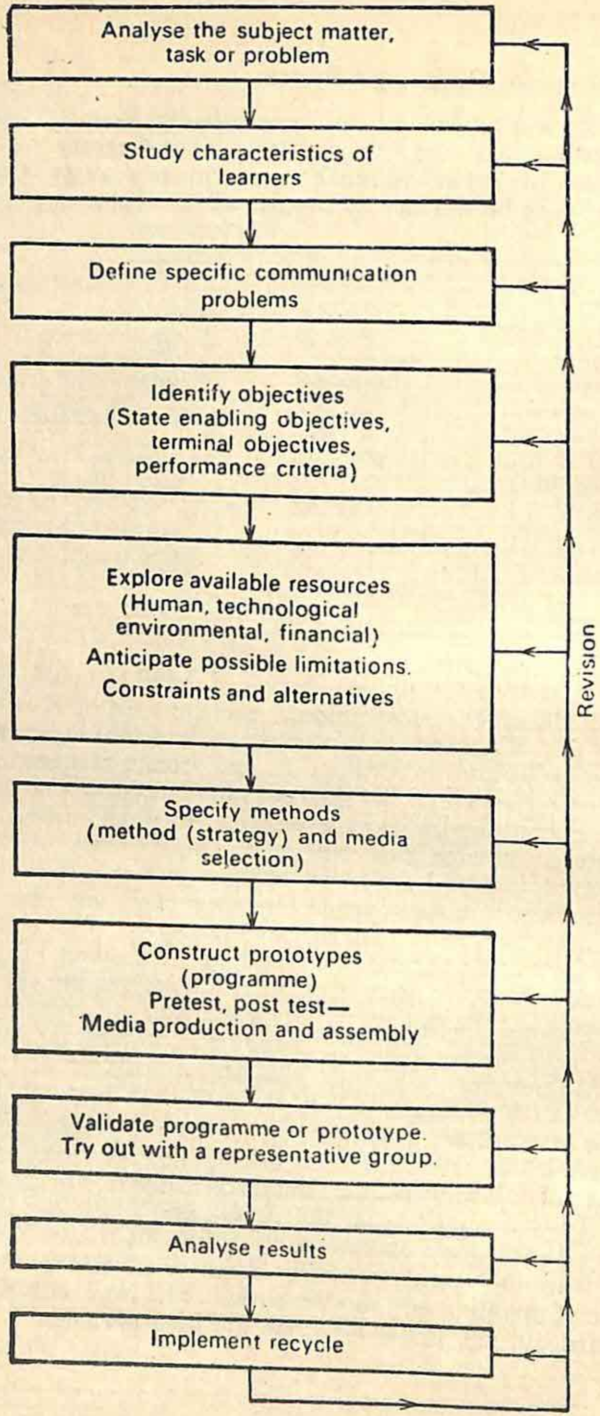
Curriculum objectives in terms of anticipated change in student behaviour should be well-defined. Teacher and pupils should know what is expected upon completion of an instructional unit. The evaluation should aim to reflect pupils' skills, knowledge, concepts developed through available teaching material and the teacher. Based on evaluation results, more appropriate instructional materials and teaching strategies could be selected to ensure achievement of stated objectives. It may be necessary also to change the prescribed entry behaviour of input based on the results of evaluation. The curriculum should be modified if end-product is not suitable to fill in the need.

Flow Diagram for Designing a System

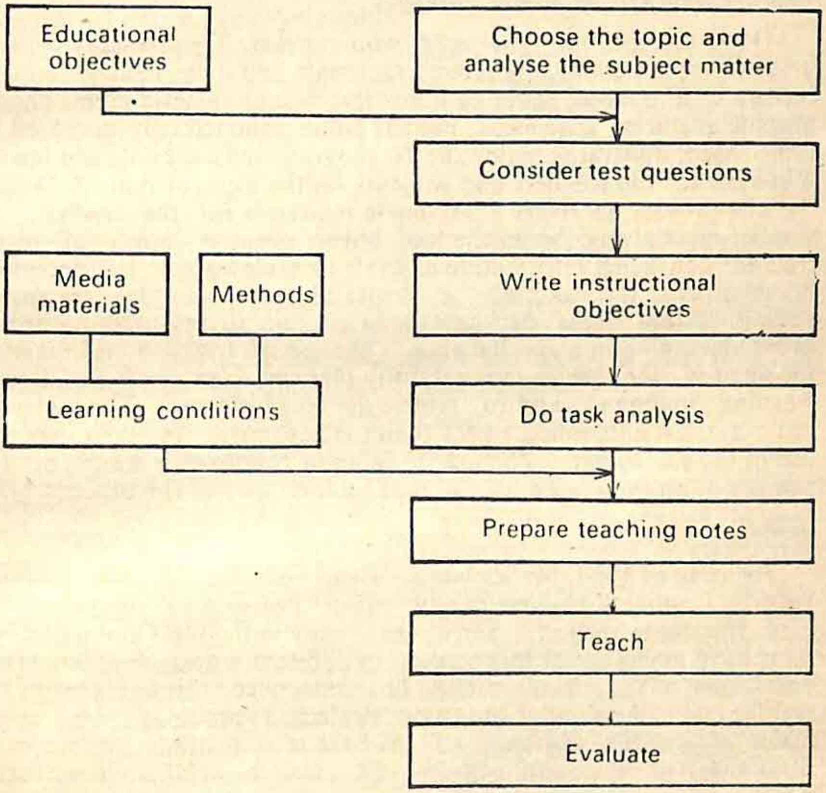
Planning is fundamental for systematising. Systems can be easily represented by drawing a map called a *flow diagram*. The relationship between the input (pupils), instructional strategy (process) and the output can be shown by means of the following simple flow diagram.



A more extended example showing in detail the path followed in general at the macro—institutional level can also be illustrated in the form of a flow diagram. Suppose we wish to develop a new course or instructional unit according to the systems concept. We should begin with a survey and analysis of subject-matter identifying the skills to be learnt and the characteristics of the learners. The specific objectives, learning outcomes and performance criteria should then be formulated. An inventory of human, technological and financial resources must be made besides considering the limitations or constraints like time, money, facilities, etc. This is the stage at which we are concerned with media along with other materials. No doubt, course construction and software production can begin only after completion of content, method and media strategies. Available materials must be reviewed and examined. Where no suitable materials are available, we must prepare a 'package' in the form of good kits. Field testing and validation provide opportunities to try out newly-developed instructional package with a representative sample of students. While full scale try out is underway, we must observe closely all aspects and note further adjustment that may be needed. Implementation is the final step of putting the validated materials into full scale operation. Continuous feedback should be obtained from the learners at every stage which should lead to a further cycle of updating and modification. The least effective methods are recycled out and better materials are incorporated.


Analyse the subject matter, task or problem
Study characteristics of learners
Define specific communication problems
Identify objectives (State enabling objectives, terminal objectives, performance criteria)
Explore available resources (Human, technological environmental, financial) Anticipate possible limitations. Constraints and alternatives
Specify methods (method (strategy) and media selection)
Construct prototypes (programme) Pretest, post test— Media production and assembly
Validate programme or prototype. Try out with a representative group.
Analyse results
Implement recycle
Revision

Similarly another example showing in detail the path followed by a teacher at the instructional level is given below. Such a flow diagram should indicate all major components of the system and show the paths that may be followed by the teacher as he proceeds through each step of the process. His interaction with human beings, media software and hardware components is shown. The flow chart is an abstract graphic model of the process. This helps to visualise the system at the planning or design stage.



Advantages of Systems Approach

1. It provides a conceptual framework on which to build plans for implementing change for education.
2. It helps to identify the suitability or otherwise of the resource material to achieve the specific goal.
3. It helps to assess the resource needs, their sources and facilities in relation to quantities, time and other factors.
4. Technological advance could be used to provide integration

of machines, media and people for attaining the defined goals.

5. It permits an orderly introduction of components demonstrated to be required for systems success in terms of student learning.
6. Rigidity in plan of action is avoided as continuous evaluation affords desired beneficial changes to be made.

Instructional Kits or Media Packages

Good kits are really *packaged mini-systems*. They usually contain a variety of systematically related materials and may include motion picture or film loops; slides or filmstrips; disc or cassette tapes; photographic pictures, specimens, models either commercially prepared or improvised; apparatus, guide sheets, programmed materials and testing materials for the teachers and students on the topic or unit. Although the kits provide necessary ready-made materials for the teacher, the teacher must always be on the look out to select a variety of materials for conveying information suitable to each learner. If necessary he must revise the materials or devise his own to suit his classroom setting. Multi-media packages may contain all resources needed to provide learning in a specific area. The use of instructional material included in the package is carefully planned to promote the desired learning outcomes and to realise the set objectives. The materials are evaluated and validated foı their effectiveness in their specific use in the classroom. The use of different resources is made by the teacher in an integrated way so that each reinforces the other.

Projects

As early as 1900, Mr Richards, Head of the Manual Training Section, Columbia University advocating "Problem-solving situations" used the term project. Since then many individuals and organisations have made use of this method in different ways. For the last 7 years some of the schools in U.K. have introduced this as a part of the regular curriculum under the name 'Project Technology', i.e., application of project teaching to the field of education. A project is whole-hearted purposeful activity proceeding in social environment.

Essentially project work is learner-centred and helps breaking down the barrier between the subjects. Thus it can be said that project teaching is the complete antithesis of classical teaching—thereby providing an excellent opportunity to the learner; (a) to experiment; (b) to discover his own abilities; and (c) to use his knowledge and initiative to specific end.

Aims and Values of Project Work in the Classroom : The aims and values of the project work in the classroom are :

1. Broadens the students educational outlook by giving some

understanding of practical application of knowledge he is gaining.

2. Develops in the student a capacity to analyse the problem systematically.
3. Develops self-confidence in him in tackling problems.

Outcome of Project Work : While working on a project the student's interest is aroused which motivates him to learn and further leads to development of his abilities.

Individual Responsibility : Project work is a sort of extended work which involves personal choice of problems and objectives, a maximum amount of individual responsibility has to be shared by him for successful completion of the project. It is agreed that some experience of extended work would constitute a good preparation for later life.

Exposure to Daily Problems of Life : The project deals with the real problems of the day-to-day utility.

Decision-making : Though the present student generation believes in making their own decision they need to be taught to base their decision on the relevant information available in the light of restraints and not forgetting the original purpose.

Teacher-Taught Relation : If the project is well planned by the teacher taking into account the student's ability, background, material availability, tools for executing the project in field in which the teacher is in-experienced there will be a considerable change in this teacher-taught relation. As such the projects should be judiciously chosen.

Types of Project Work

Observation Projects;
Collection Projects;
Dissection Projects;
Construction Projects;
Control Projects;
Survey Projects;
Social Projects;
Reading and information projects.

How to Approach Project Work : In order to obtain the specific end by project work one has to follow a systematic line of action, which is given below :

(a) Identify the problem
(b) Specify the problem
(c) Propose alternate solutions
(d) Choose the best
(e) Complete the design

S.C.E.R.T., West Bengal
Library
Calcutta
25/3

(f) Procure the required material
(g) Make and assemble
(h) Test and compare with the original purpose.

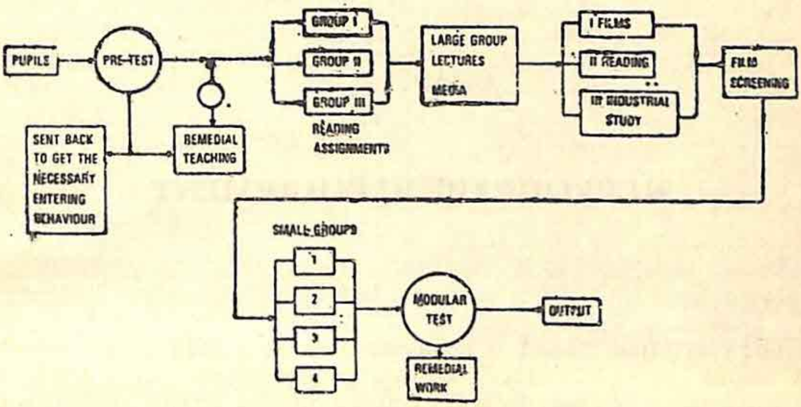
Throughout this line of action, the teacher plays a very important role in guiding the student step by step and leading the student to the solution by making him think, refer to reference library and perform some minor experiments, arrange for group discussions and lectures by experts of local industry. Help must be given to the student whenever required but at the same time the teacher should not involve himself completely in the project.

Role of Teacher in Project Work : The teacher's role is crucial while the student is developing his abilities. The teacher has to

1. act as a guide throughout the work. Not just give the problem and ask the student to bother about the solution for himself. This type of attitude defeats the sole purpose of project teaching,
2. ensure that the student has necessary background and is capable of being extended by further study and work,
3. act as a source of morale,
4. choose the project properly and exercise control as wrong choice and failure of the teacher to control will lead to frustration instead of enthusiasm in the participants,
5. Check up before hand that required materials to make the components themselves are available and necessary working tools are available,
6. be convinced that the project is within the capacity of pupil as easy and can be completed,
7. assist the project to advance without deeply involving himself in it,
8. ensure that the project selected should have a definite educational value,
9. be able to assess the time required for the entire project work,
10. decide whether it should be an individual project or group project.

Restraints on Selection of Project Work : (1) Financial considerations, (2) Time available—often this is done out of normal class hours, (3) Type of background knowledge the student possesses, (4) Individual ability of the student, (5) Not feasible to cover entire syllabus by this method and if attempted there will be gaps left in the knowledge, (6) The teacher guiding should be enthusiastic and should be efficient.

PUPIL LEVEL MODULAR SCHEDULING



CHAPTER VI

REPROGRAPHIC EQUIPMENT

Reprography

The very rapid rate of advancement of knowledge in the present day could be rightly called "knowledge explosion". It is necessary for the teacher of today to make full use of all available resources to impart the knowledge easily and accurately to pupils. All possible modes of communication should be harnessed to effect the same. Significant improvements in the reproduction processes have added to our ability to share information. They have freed learning from dependence upon typewriter, carbon paper and chalkboard as principal means of communicating locally developed ideas in written forms to a large number of students.

Reprography is a branch of technology dealing about methods of duplication or reproduction. The method of reproduction to be selected depends upon the nature and number of copies required and nature of original (more written matter, with diagrams, coloured or black and white, etc.)

Duplicated instructional materials are widely used in the classroom. Teachers find numerous uses for them to fill in the work book assignments, assignment direction sheets, study guides, list of points to look for and guide questions in connection with film showings, class and school newspapers, examination and quizzes and hundreds of similar purposes.

To make use of duplicated materials the teacher should know (a) the characteristics of various widely used duplicating processes, (b) the special advantages and disadvantages of these processes, (c) the specific use to which any process could be used effectively, (d) to produce the master copy for reproducing materials by such means, and (e) to operate various types of duplicating equipment.

Reproduction enables preparation of one or more identical copies of the original, same size or of different size in monochrome or colour. Duplicating involves making a number of identical copies of original.

Blue Print

Reproductions of line drawings drawn with black pencil or Indian ink on any transluscent paper (butter paper, tissue paper, etc.) can be reproduced on specially sensitised paper surfaces. In the case of blue prints, the drawings would be reproduced as a white line on a blue background. The required diagram is drawn to scale on tracing paper preferably with Indian ink. Thick drawing paper would be most suitable for this purpose. A glossy surface is not desirable.

Sensitising Solution

Thirty grams of ferric-ammonium-citrate is dissolved in 100 ml of water. The solution is kept in a dark bottle or is kept in a plain glass bottle, it can be covered with opaque paper or kept in a dark place. (Solution A)

Ten grams of potassium ferri-cyanide is dissolved in 80 ml of water. To this solution is added another solution of 5 grams of gum Arabic dissolved in 20 ml of water. (Solution B)

Just before use, equal volumes of the two solutions are mixed and coated evenly on the drawing paper with a brush and allowed to dry in a dark place. The trace is kept over the sensitised paper so that when looked at from above the diagram is seen in proper orientation and the sensitive surface is in contact with the back of butter paper.

The two can be kept in close contact in a printing frame. The unit is exposed to bright sunlight. According to the intensity of sunlight, the time of exposure will vary from 3 to 8 minutes. Too little exposure will result in a faint blue picture with white lines; correct exposure will result in good contrast between diagram and background. Long exposure will result in a dense blue background.

After exposure the sensitised paper is put in a dish containing water acidulated with a small quantity of hydrochloric acid. The picture will develop. The paper is washed with water. Surplus moisture is removed by pressing it between two blotting sheets and allowed to dry. Blue print can be used to reproduce only line drawings.

Spirit Duplicator or Hectographing

Requirements : (1) Master sheet, (2) Special carbon paper, (3) Alcohol—methylated spirit or wood and gram alcohol will be sufficient.

Special Advantage. Since special carbon paper for use with spirit duplicators is available in assorted colours, reproduction in colours is possible up to 100 or more copies from a carefully prepared master and utilising special glazed impression papers. To prepare master, place master sheet over carbon paper, the carbon side up in contact with the adhesive coated side of master sheet. The master sheet carbon paper unit is placed on a backing sheet (Acetate sheet can be used as a backing sheet or any plastic sheet or hard board or metal sheet also could be used.) Writing or drawing on the master sheet may be done with 2-4 H pencil or ball point pen. A rounded end is preferable to a sharp point. When a different colour is required, the carbon paper is changed to one of desired colour.

Wherever the master sheet has been pressed by writing or drawing tool, the spirit soluble dye in the carbon paper would adhere to the coated side of the master sheet. Any correction required to be made could be effected by removing the adhering dye at the spot by scraping and rewriting, using fresh carbon paper area.

Duplicator

Since impression is formed by part of dye on master sheet, it is necessary to get more impressions as only a small quantity of the dye is absorbed per impression. Hence glazed paper should be used. In the case of spirit duplicators the dye absorbed surface of the master sheet *should come into contact* with paper on which impression is made.

Ink Duplicator

This involves the use of wax coated stencil. The stylus used for cutting the stencil removes the wax coating. The viscous liquid ink permeates through the portion from which wax had been removed and is absorbed by the impression paper. Impression paper should be unglazed type to absorb and dry ink quickly. Special styluses and shading plates are available for various lettering effects. Any correction necessary could be made by coating the surface with the correction fluid by gently rubbing with a glass rod after moistening the end with correction fluid or applying the correction fluid with a brush, allowing the same to dry and retyping or rewriting.

Steps to Use Ink Duplicator

(1) Check the ink supply. Apply ink if necessary.
(2) Attach stencil—place the stencil face down on the revolving drum with the stiff backing sheet up, towards the operator.
(3) Clamp the stencil top into place.
(4) Rotate the revolving drum a few times, press the stiff backing sheet on the stencil (make sure the stencil is in perfect contact with the drum at all places with no air packets anywhere).
(5) Clamp the stencil tail if necessary.

(6) Run a few trial copies, adjust margins up and down. Stack and adjust neatly papers on paper platform.

(7) Run the machine, check the quality of impression, stand by the machine to stop it if papers jam or any other difficulty arises. Ink if necessary after stopping the machine.

(8) Remove stencil and do the necessary cleaning of the machine etc., for the machine to be used again. Stencil if required for future use can be removed from the machine by placing a protective thick absorbent paper cover over it while the stencil is on the drum, pressing the same against the stencil and carefully removing the same. It could be used even after one or two years. With a good stencil, used in a well maintained duplicator even 5,000 copies could be taken.

Other Duplicators

Electronic stencil cutters use special stencils and any matter in original could be cut as stencil easily and the stencil used in ordinary ink duplicator to get copies.

Other duplicating devices available are thermofax (infra-red copier), reflex printing, diffusion copier, electrostatic copier. Electrostatic copiers like Xerox are now available. An electrostatic copier enables one to take a single or a number of copies on ordinary unprepared material paper with the same size as original.

Other Processes

Screen printing process is not very difficult; reproduction in colour are possible by this process.

For larger institutions, an offset printing machine would be an useful possession.

Reflex Printing

It is possible to reproduce any picture on a plane surface by a photographic process known as *Reflex Printing* process. The reproductions will be in black and white, same size and any number of copies can be taken from one negative. The process does not require any camera. Copies of diagrams, pictures from costly books or magazines can be reproduced on reflex paper.

The process is simple and within the capacity of an average high school pupil. Incidentally he gets an insight into technique of photographic reproduction of objects.

The Need for Reflex Printing in Teaching

For the projection with an Epidiascope, the particular page must be kept flatly pressed against the object frame of the Epidiascope. This is not possible if the book is very large and thick. Further though there is forced ventilation and cooling arrangements in costly Epidiascopes, any book if exposed to that intense heat for a long time will be spoiled. Sometimes it may be necessary to project portions of maps on charts. It is easy to take Reflex Print of the picture or portion of chart or map and project the same in Epidiascope. Even if one print is spoiled, another can be easily taken. There is only one drawback, for the print will be only in *monochrome*.

Chemicals and Equipment Required

1. All photographic papers are sensitive to light and will be spoiled if exposed to light. For working with reflex printing paper, orange 15 watt bulb may be used. 5 cm round lamp or pigmy lamp would be suitable. The unexposed paper should not be taken very near the lamp.
2. Three shallow dishes of suitable size, glass or enamel coated iron or plastic or stainless steel dishes can be used. Plastic basins or buckets will also be required.
3. The following chemicals will be required for the developing solution. The formulae for making the developer will differ for different papers.

Formula for Reflex Paper—Agfa c.90 etc

1. Metol	1 gm
2. Sodium Sulphite (Anhydrous)	13 gms
3. Hydroquinone	3 gms
4. Sodium Carbonate (Anhydrous)	26 gms
5. Potassium Bromide	1 gm
6. Distilled water	1000 ml

The chemicals are dissolved in the order given. The prepared developer will remain for one month if a bottle ful is kept in a dark place, or in a red or amber bottle but it is not desirable to make large quantities and keep in store. It is also necessary to use fresh developer daily and change the developer as soon as it becomes coloured. Formula for any paper will be given in a separate pamphlet, kept inside the paper packet.

4. *Fixing bath* : Fixing bath is made by dissolving 200 gms of hypo, 20 gms of potassium or sodium metabi sulphite in 1000 ml of water.

5. *Printing lamp* : Any lamp, preferably frosted of wattage from 60 to 100 can be used. The lamp is kept at a distance of about 18" from table surface. This will illuminate an area of about 8" square uniformly. If a larger area picture is to be reproduced, a battery of lamps must be used for uniform illumination. The lamp switch must be near at a convenient place.

Arrangement before Printing

1. A dish containing developer
2. Basin or bucket or large dish full of water
3. Dish containing fixing bath (Hypo)
4. Another basin or bucket full of water.

Working Proper

The safe lamp is switched on; the paper packet is opened; and a strip of paper is cut. The sensitive paper surface can be identified easily by its appearance; it will be slightly darker than the other side. Sensitive paper should be handled by edges only and should not be touched by moist hands.

The book with the proper page opened is placed directly below the printing lamp. The vertical through the centre of lamp must pass through the centre of picture to be reproduced. The sensitive paper strip must be placed on the picture, the sensitive surface is in contact with the picture. It is kept pressed by a thick plane glass sheet. It is absolutely essential that the reflex paper is kept pressed flat against the picture as otherwise loss of definition will result. Before switching on the printing lamp it must be seen that no unexposed paper is kept outside.

The lamp is switched on. A cardboard paper is moved over in steps so that different parts of paper get different known exposures. Time can be reckoned with a stop watch or by counting at constant rate. The printing lamp is switched off.

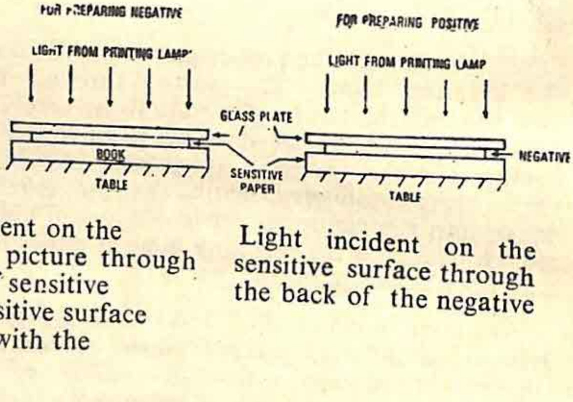
The reflex paper is transferred to developer. The entire surface must be immersed in the solution at the same instant. The picture must develop within a minute. Failure to do so may be due to smaller exposure time or weakened developer. The paper is transferred to basin of water and later put in the hypo bath. When the print has remained in hypo bath for about 5 minutes, white light can be switched on. The test strip will give an idea of exposure time for the particular lamp kept at the distance. If the distance is increased the exposure time also must be increased. Exposure time will vary directly as the square of distance.

The process is repeated with a correct size paper with the exposure time corresponding to the time given for the portion of the test strip where the image is reproduced properly. The negative after remaining in the fixing bath for 5 minutes is washed well in running water and dried by hanging with a clip or spreading over clean bloting paper. In the paper negative, a black line diagram on white paper will appear as a white line diagram on a black background. There will be lateral inversion.

Positive Printing

For positive printing exposure is made through the back of negative; the reflex printing paper is placed below. Sensitive side of the reflex printing paper will be in contact with the negative image on the negative print. Here another unexposed paper takes the place of the picture. Positive printing can be done with a printing frame and there will be perfect contact in all places between the negative and unexposed paper.

Exposure time is determined as before with a test strip. Processing is the same as for negative.



Light incident on the diagram or picture through the back of sensitive paper. Sensitive surface in contact with the diagram

Light incident on the sensitive surface through the back of the negative

Handouts

Handouts are sheets of paper given to pupils at the start of a period or at the end of the period. These sheets contain specific information which the teacher desires to convey to the pupils. If it is necessary, for the pupils to have the information during the class sessions, the handout is issued at the start. The information is duplicated by (i) spirit duplication process, (ii) ink duplication process, (iii) pencil and carbon copies (for a small number) or (iv) roto print process or any other duplicating process. The information may be typed or handwritten. It may contain diagrams, pictures, etc. It is highly important that impressions are clear so that the same can be easily read. Handouts may contain :

(1) Assignments for the pupils.

(2) Instructions for operating any machine.

(3) Instructions for doing a particular experiment or complete a specific process.

(4) For giving directions to select suitable study materials.

(5) For giving any information necessary but not available in the prescribed text book.

(6) For giving a summary of the subject-matter covered during the period, to serve as reference to pupils.

It should be remembered that the types of handouts listed except No. 1 and 4 may, if given too frequently, choke the study habits of pupils; pupils will not care to read books, even text books or make use of the library, if ready-made material—containing the necessary information in abridged form is available for ready use. Some pupils will not take any class notes, few may not even attend the class, and even if physically present in the class may not be paying any attention to what is happening in the class. Yet the handout if used infrequently and for the purpose listed as items 1, 2, 3, 4, 5 will be of use and sometimes necessary.

Photography

Photography as a hobby is pursued by many. Some of them have developed considerable skill that they are able to make the hobby pay and become a profitable pastime. At present varieties of cameras available are limited due to import restrictions and sensitive materials like films, papers, etc., are costly and not easily available. Our country has started manufacturing cameras and sensitive materials like positive films, dia-positive films, reflex and bromide papers.

The sensitivity of photographic materials now available is so high that costly cameras with wide aperture lenses are not absolutely needed. Even with a simple box camera it is possible in comparatively poor light to photograph action.

Use in Education

Excursions to places of interest by school children under the guidance of teachers have become quite common. Such excursions provide direct experience with events, objects, etc., and during the trip, photographs may be taken of the places visited, things seen and these may be displayed on the school bulletin board. Pupils may also use these photographs to illustrate hand-written booklets prepared by them about the field trip and may sometimes use these pictures in their school magazine. It is possible to take transparency using dia-positive film and the same can be projected using a slide projector. Colour, of course, will add realism to photographs but at present the cost and the complicated process involved in taking colour prints will be a restraint.

Many institutions have included photography as one of the activities under Science and Hobby Clubs. Photography has also been included as an activity under work experience. Photography is an important tool for visual literacy.

Types of Cameras

Every teacher is familiar with the principle of a photographic camera, with its lens, iris, shutter and negative film in a dark and opaque box with or without bellows.

1. Fixed focus simple box camera with single speed shutter
2. Box camera with two speed shutter, adjustable iris portrait attachment and filter
3. All metal reflex: (a) single lens; (b) double lens
4. Cameras with bellows
5. Miniature cameras with coupled range finder
6. Old model field cameras using plates (single or double extension or triple extension.)

Costly camera with elaborate adjustments for handling requires good knowledge of fundamentals of photography and in the hands of a beginner or young pupil may not provide good results whereas with a cheap box camera they may produce good pictures. It is always desirable and necessary to study the instruction booklet issued with each camera before one attempts to use the same. Beginners should attempt photographing static objects in bright sunlight before attempting close-ups and photographs of live persons.

The Lens

Modern camera lenses are compound lenses made up of a number of single lenses, concave and convex of different focal lengths, different types of glasses, fitted as a unit. Such a compound lens is necessary to form an accurate image of a multi-coloured object in a plane using a single convex lens. The front surface of all the lenses are coated by electrical method with a thin layer of magnesium fluoride to increase the percentage of transmitted light.

The lens combination is convergent, i.e., parallel rays incident on the surface will be brought to focus. There is an adjustable iris diaphram between the elements of the lens by which the light admitting area of the lens system may be altered. There is a shutter with different speeds of opening.

Depth of focus: If the lens is kept fully open more light is admitted and for a film of a particular speed comparatively shorter exposure time will be sufficient. Decreasing the area of opening which will result in decrease of admitted light and thereby the exposure time may be longer. But with moving objects, exposures greater than 1/25 of a second may cause blur.

If 'f' is the focal length of lens and 'd' is the diameter of the transparent opening, f/d is called the F number numerical aperture. The smaller the opening the greater will be the F number.

When a landscape is being photographed, there are objects at various distances from the camera; let it also be assumed that to add human value, there are persons in the foreground. With a wide aperture, if the foreground is focussed, the background will be out of focus and vice versa. Cutting down the aperture will result in various objects at different distances being in focus. The smaller the opening the greater will be the depth of focus, i.e., the range of distant objects that are in focus will be greater. For example, for Zeiss Tessar f 7.5 cm lens, camera focussed at 15′,

F 3.5 — depth of focus 12′ — 20′
F 8 — depth of focus 10′ — 30′
F 16 — depth of focus 8′ — 60′

Focussing : The iris diaphram helps in securing the required depth of focus. There is provision in all cameras for focussing either the entire lens system moving to and fro resulting in alteration of its distances from the sensitive film or by adjusting the distance between the front element unit and the back element unit, of the compound lens.

Shutter: In some cameras (35 mm cameras) the shutter is not between the lens units but is located before the film plane. Such a shutter is called *Focal Plane Shutter*. Advantages of the shutter is that it is possible to change from lens of one focal length to another with the film in the camera. Longer focal length lens will result in narrowing of field of view. Object at the distance will fill in the picture area to a greater extent. This can be secured by attaching additional lens system called *Telephoto lens*.

Wide angle lenses are of shorter focal length and hence their use will enable to compress large field of view in the picture.

Focal length of the normal lens will depend upon the size of the picture negative, and will be approximately equal to the diagonal of picture area. For example, in a camera using 35 mm film, picture size is 24 mm × 36 mm.

Focal length of the normal lens is 5 cm
Focal length of the telephoto lens $>$ 5 cm
Focal length of the wide angle lens $<$ 5 cm

Exposure Time: The time of exposure to be given will depend upon the various factors, in addition to numerical aperture.

(a) Lighting condition,
(b) Nature of the subject,
(c) Colour of the filter used, if any
(d) Type of film.

Though it is desirable to use an exposure meter, it is possible after some practice to estimate the correct exposure required.

The film emulsion has latitude. Even five times the normal exposure may yield a fairly good negative in the case of certain films. When in doubt it is always desirable to give a comparatively longer exposure. Moving objects require very short exposure and exposure time also depends upon relative direction and rate of motion of the object.

Filters: To produce some special effects, for example, clouds in sky, etc., filters can be used. Filters are available in colours, light yellow, orange, red, blue, ultraviolet and relatively longer exposures than normal, will be required depending on the type of filter used.

Negative Materials: Normally most of the cameras marketed are designed to use the (1) 120 size film width 2½", resulting in picture size of 2¼" × 1⅝" or 2¼" × 2¼" or 3¼" × 2¼" and (2) 35 mm perforated film resulting in picture of size 36 mm × 24 mm or demi size 24 mm × 18 mm.

Films are available with a range of light and colour sensitivity :

(a) Slow orthochromatic materials—insensitive to red light
(b) Panchromatic materials—sensitive to all colours
(c) Ultra speed panchromatic materials
(d) Fine grain panchromatic materials

The fastest films available at present are those with a speed greater than 400 ASA which makes it possible to take photographs of a person about to light a cigarette with the light provided by a match flame only, at speed 1/25 of a second and aperture F 5.6.

Processing the Negative: All sensitive materials should be *handled* in total darkness and it is very advantageous to use developing tanks which will ensure uniform development.

The ingredients of the developer should be dissolved in the orde given :

FINE GRAIN DEVELOPER

Metol (ELON)	2 gms
Sodium sulphite (anhydrous)	100 gms
Hydroquinone	4 gms
Borax	2 gms
Water	1000 ml

Time of development : 15 to 17 minutes at temperature 18°C

Hardening bath : 25 gms of Chrome Alum in 1000 ml of water—Time 5 minutes

Fixing bath : 250 gms of Hypo in 1000 ml of water—Time 5 minutes

Processing order:

1. Developer—15 to 17 minutes at 18°C
2. Washing in water
3. Hardening—5 minutes
4. Washing in water
5. Fixing 5 minutes
6. Washing in running water for 10 minutes, Excess of water is shaken and
7. The film is allowed to dry in dust-free room.

Printing Positives—Contact Prints—Enlargements

In the printing of positives one must ensure that there is no lateral inversion. In the case of contact printing the emulsion side of the negative is to be in contact with the sensitive surface of the contact paper. When enlarging, the emulsion side of the negative should face the enlarger lens. Test strips for determining time of exposure should be taken as in the case of reflex printing. In the case of bromide paper, the safe light, should be red and the paper should not be exposed to even red light for long time. Contact paper and Bromide paper are available in two thicknesses—-Single weight (thin) and Double weight (thick) varieties of surfaces finish Glossy Matt, Velvet, etc., and of different sensitivities to light—Soft, normal and hard (relatively not so sensitive).

For a dense negative (appearing almost opaque), soft paper should be used and for a thin negative (appearing almost transparent) a hard paper should be used.

Developer: Composition for the developer is given below. The chemicals are dissolved in the order given.

Metol	1 gm	
Sodium Sulphite (anhydrous)	13 gms	May also be used if a high contrast negative is required (for negative material)
Hydro Quinone	3 gms	
Sodium Carbonate (anhydrous)	26 gms	
Potassium Bromide	1 gm	
Water	1000 ml	

Developing Time—3 mm 30°C

An image should appear in 1½-2 minutes and delay in the appearance of the image is due to shorter exposure. Forcing in the image in such a case by retaining the prints in the developer for a longer time will result in yellow stained prints.

The entire paper surface should be covered with developer at the same instant. As soon as the development is complete the paper is transferred to a larger reservoir of water which dilutes the surface adhering developer and considerably closes down its action immediately. Acetic acid may also be used to arrest development. (Stop bath)

Fixer: 250 gms of Hypo and 25 gms of Potassium Meta-bisulphite are dissolved in 1000 ml of water. The rinsed paper after development is transferred to the fixing bath and allowed to remain for 5 minutes and then washed for 10 minutes in running water to remove Hypo. This long washing is necessary as otherwise prints will turn yellow. When in Hypo the prints should not be one over the other. The prints should be trimmed when dry with a trimmer.

For transparencies, contact prints or enlargements may be done with 35 mm positive film or lantern slide plates *or Dia Positive Acetate film*.

The mounted prints may be coloured with transparent water colour in stages remembering that if any portion of it becomes dark, it is not possible to decrease the density of colour. Photographs can be mounted with photo corners or with good quality paste applied uniformly on back with a brush, and pressing the prints uniformly to the surface, of mount or page of album.

Steps in Taking a Photograph:

(a) Loading the camera with suitable film

(b) Selection of shutter speed and lens aperture to suit lighting conditions

(c) Required view

(d) Exposure

(e) Processing the Negative—Developing—Hardening—Fixing—Washing

(f) Printing Contact Or Enlarging — Developing — Fixing — Washing

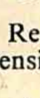
(g) Mounting the print in mount or album

Reduction of a dense negative can be done using Reducer and intensification of thin negative can be done using Intensifier.

Physics of Photography—Lenses

Lenses are used in photographic cameras and in projectors to form real images of objects, diminished in size in the case of photographic camera and enlarged in size in the case of enlarger and projector. Since real images are to be formed, convex lens should be used. Convex lens converges parallel rays incident on it and parallel to the principal axis to a point called the *principal focus*. The distance between the optic centre of the lens and the principal focus is called the *focal length* of the lens. In the case of a concave lens, the focus is virtual. Concave lens is designated as a divergent lens.

The following are some types of lenses: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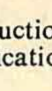
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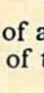
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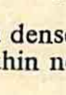
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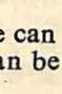
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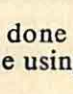
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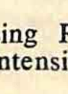
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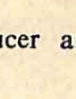
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1. Biconvex (R_1 not equal to R_2) R_1 & R_2 — radii of curvature of either side
2. Equi-biconvex ($R_1 = R_2$)
3. Plano Convex $R_2 = \infty$
4. Convex menescus
5. Biconcave lens (R_1 not equal to R_2)

6. Equi-biconcave ($R_1 = R_2$)
7. Plano Concave $R_2 = \infty$
8. Concave menescus (1-4 : Converging lenses, 5-8 Diverging lenses).

Lenses are made up of special glass (Optical glass). Refractive index μ for Sodium line (D line) Crown glass 1.48 — 1.61 (depending on composition). Flint — Dense flint — Extra dense flint 1.53-1.96. The spherical surfaces are worked to precision so that the departure from normal radius does not exceed the order of wavelength of yellow Sodium line — 5893×10^{-10} metres. The surface is said to be optically worked.

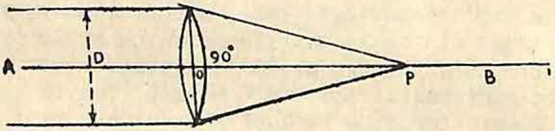
The focal length of a lens is given by the formula.

$$\frac{1}{F} = (\mu - 1) \left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

F — where focal length

μ — Refractive Index of material of lens.

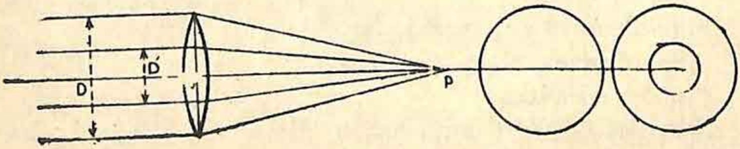
R_1, R_2 — Convex surface is considered positive.
— Concave surface is considered negative.



O—Optic centre
P—Principal focus
D—Diameter of face of length
AB—Principal axis
OP—Focal length (f)

f/*D*—ratio of focal length to diameter is called numerical aperture (mere number) f is expressed in cms.

To describe a lens in addition to focal length, the numerical aperture also should be mentioned.



If an opaque partition with a smaller circular opening (D_1) is kept before the lens, the light admitted through the lens is reduced. The focal length is not altered but the numerical aperture is changed.

$$f/D < f/D_1 \text{ since } D_1 < D$$

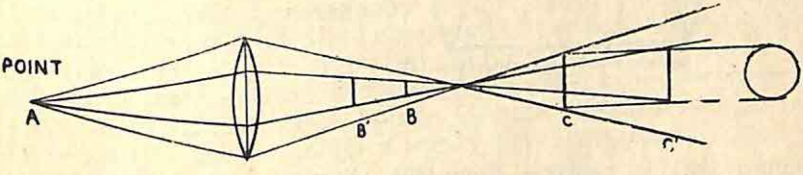
This is called putting a stop before the lens. In compartively costlier cameras, there is an opaque diaphram (multi-bladed) with a central circular hole diameter of which could be varied. This iris diaphram could be adjusted to have full opening or to pin-point opening.

As the iris closed, the light admitted through the lens is reduced but the depth of focus increases.

For a convex lens $\frac{1}{f} = \frac{-1}{v} + \frac{1}{u}$

f—focal length, u — distance of object from the lens
v—distance of image from the lens.

f cannot be altered since it is decided by the radii of curvature of surfaces and the refractive index of the material of the lens. v is kept fixed in the case of a camera and corresponds to the distance between lens and the sensitive film or plate. When photographing objects, it will not happen if all the objects included in the field are at the same distance. If one object is focussed, the other will be out of focus. In the case of a larger object, different parts will not be in focus. This effect should be counteracted to certain extent by reducing the aperture. (More exposure is needed under the same lighting conditions.) But the depth of field in which objects will appear to be in focus will increase. As a matter of fact, this illusion is caused by the fact that eye has finite resolving power. Upto a certain dimension in the diameter of a circle, it appears as a point.



With full aperture the latitude of movement of film plane is BC. With cut down aperture, it is $B'C'$. $B'C' > BC$. The image of point A will appear to be reproduced as a point when the focal plane is located between B & C or B' & C'. The refractive index of transparent material varies with the colour of incident light. Since the focal length of a lens depends upon refractive index, the focal length also will vary with colour. In a multi-coloured object, different coloured portions will not be brought to focus at the same plane. The image will be distorted in colour. This defect is called the *chromatic aberration.*

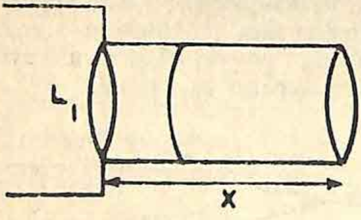
There are other defects associated with images formed using a single convex lens due to spherical aberration. Distortion of the image called pin-cushion distortion, barrel distortion etc., also result. Astigmatism is caused by oblique incidence of light rays.

All these defects could be eliminated by a combination of lenses called the *compound lens*. A compound lens is a combination of a number of single lenses, convex or concave made up of different materials (optical glasses) designed and mounted coaxially so that the resultant image is free from distortions and aberrations. All surfaces are optically worked. The iris stop is usually kept between the lens components.

A compound lens made up of n — single lenses is called n-element lens. The surfaces of element may be in contact or separated or cemented. The compound lens is designed to be convergent lens.

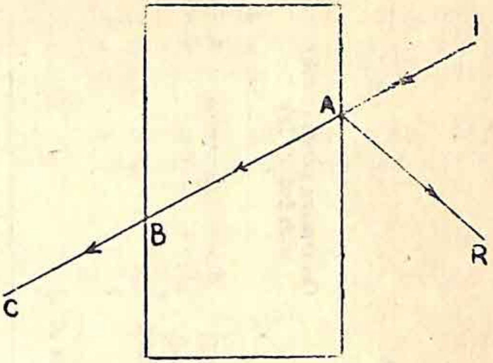
The focal length f of two single lenses of focal length f_1 & f_2 separated by distance x is given by $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{x}{f_1 f_2}$. f is altered by altering x. f_1 and f_2 may be focal length of lens combination designed for perfect image formation.

Compound lenses



By altering x, the focal length of the compound lens could be altered.

Such a lens is called a *Zoom lens*. Zoom lenses are used in movie cameras and projectors.



Coated Lenses: When light is incident on a transparent surface major part is transmitted and small percentage of it is reflected. Under certain incident angle condition, 20% of light is reflected. In a compound lens involving light incident on a number of surfaces loss of light due to successive reflection will reduce the intrinsic brightness of the image formed. The image will be brighter if a percentage of reflected light could be reduced thereby increasing the percentage of transmitted light. This could be done by coating on the surface of the lens a transparent film of refractive index midway between that of glass and air.

Magnesium Fluoride is deposited as a very thin film (vacuum—thermal deposition), a few molecular layers thick. This film coating increases the percentage of transmitted light. A thin film will exhibit colours by reflected light. This is due to the phenomenon of interference of light reflected from the front and back surface of the film. Coated lenses will appear coloured by reflected light.

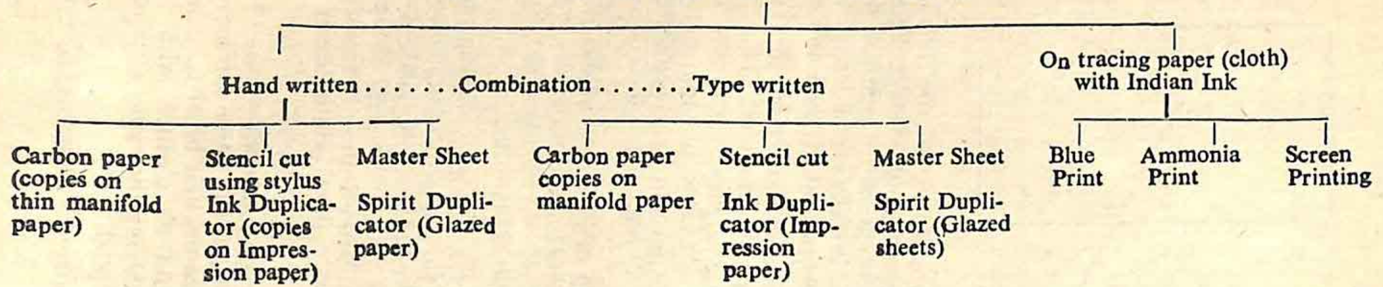
All lens surfaces (in the direction of incident light) of lens elements used in photographic cameras and projectors are coated to reduce the loss by reflection. The inside of lens assembly tubes are painted dull black to prevent internal reflections.

Care of Lenses: Lenses should be kept clean. The surfaces should not be touched with hand. Lenses should not be subjected to humid conditions. It is not unusual to keep lenses in plastic screwed containers. A bag containing activated Silica gel is kept along with it to keep the enclosure dry. Fungus formation on lens surface cannot be removed. This will occur if lens is kept continuously for a long time in a humid atmosphere.

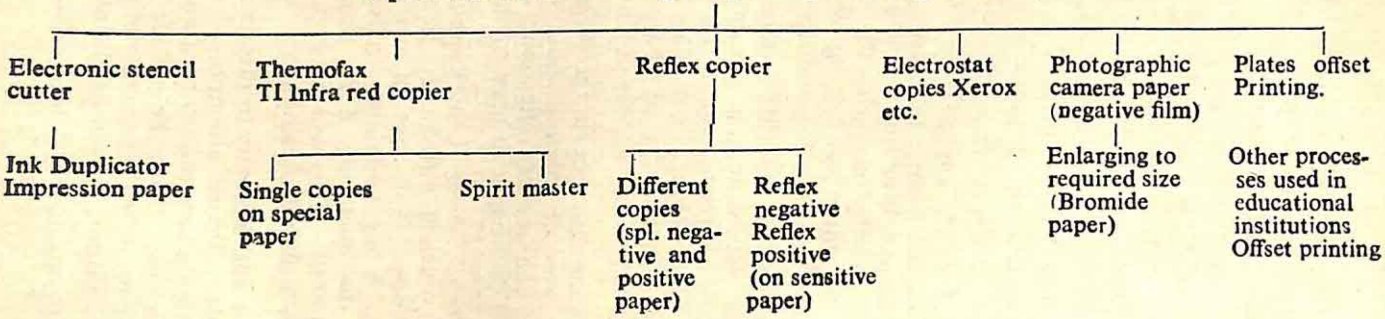
It is not necessary to dissect a compound lens to clean the interior surfaces. Before attempting to clean the outer surfaces, dirt, dust etc., should be removed by a good camel hair brush specially kept for the purpose. Then the surface could be cleaned with lens cleaning tissue or lens cleaning cloth applying the same without any pressure. Polishing should not be attempted.

If the surface has been contaminated with grease or oil (normally

Reproduction (Preparing Originals and Copying)


Hand written . . . . . . .Combination . . . . . . .Type written
On tracing paper (cloth) with Indian Ink
Carbon paper (copies on thin manifold paper)
Stencil cut using stylus Ink Duplicator (copies on Impression paper)
Master Sheet Spirit Duplicator (Glazed paper)
Carbon paper copies on manifold paper
Stencil cut Ink Duplicator (Impression paper)
Master Sheet Spirit Duplicator (Glazed sheets)
Blue Print
Ammonia Print
Screen Printing

Reproduction from Existing Originals (Book diagrams etc.)


Electronic stencil cutter
Ink Duplicator Impression paper
Thermofax TI Infra red copier
Single copies on special paper
Spirit master
Reflex copier
Different copies (spl. negative and positive paper)
Reflex negative Reflex positive (on sensitive paper)
Electrostat copies Xerox etc.
Photographic camera paper (negative film)
Enlarging to required size (Bromide paper)
Plates offset Printing.
Other processes used in educational institutions Offset printing

this should not happen) Kodak lens cleaning liquid should be used, after removing dirt, dust with a camel hair brush applying a little liquid allowing the same to evaporate and wiping with lens cleaning tissue or special soft cloth.

Lens cover should be used when not in use to prevent dirt, dust, sand etc., falling of surface. Acid, soap, detergent etc., *should not* be used to clean lens surfaces.

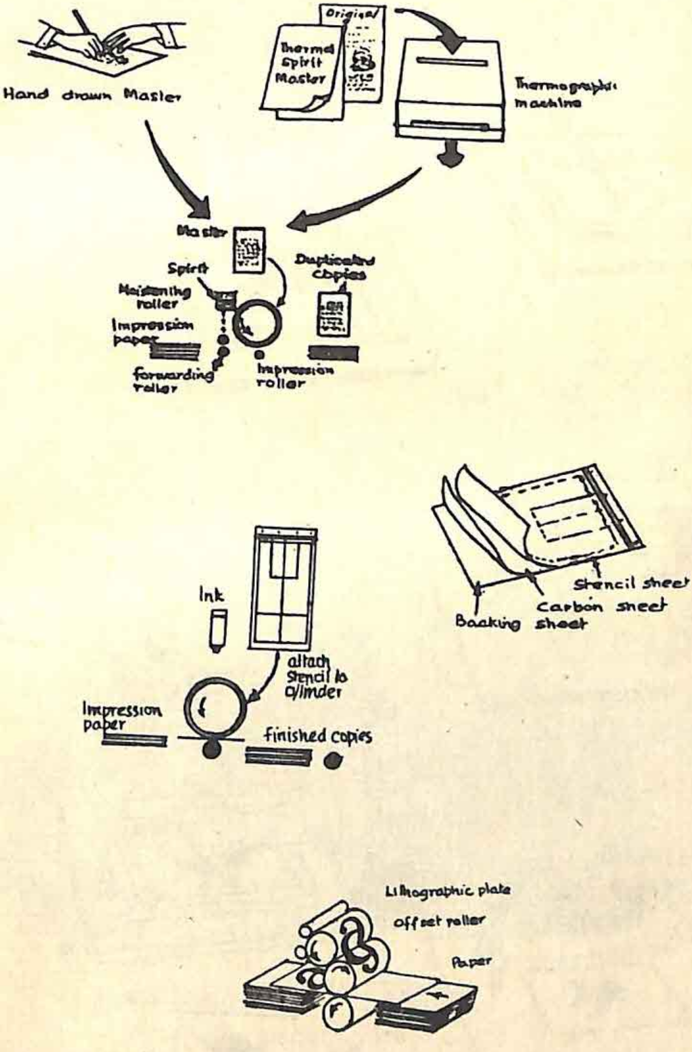


Fig. 6.1
Duplicating Equipment

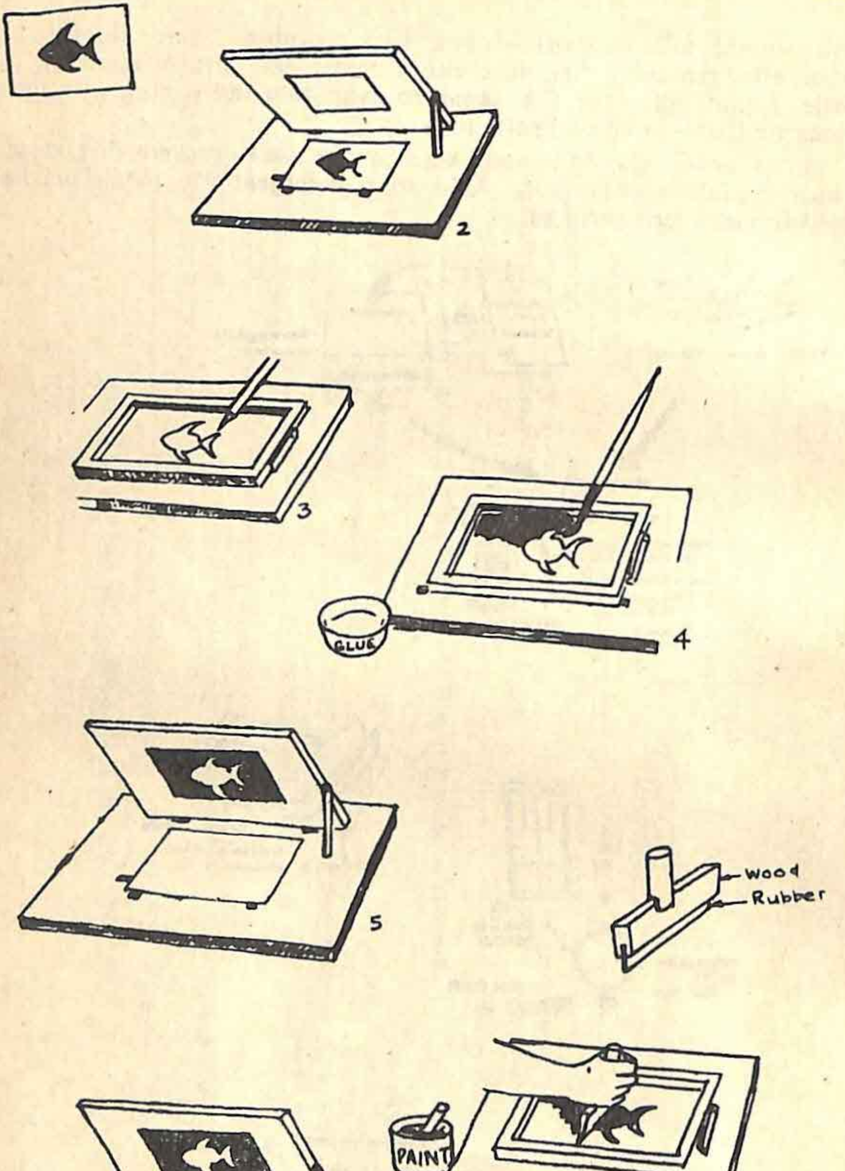
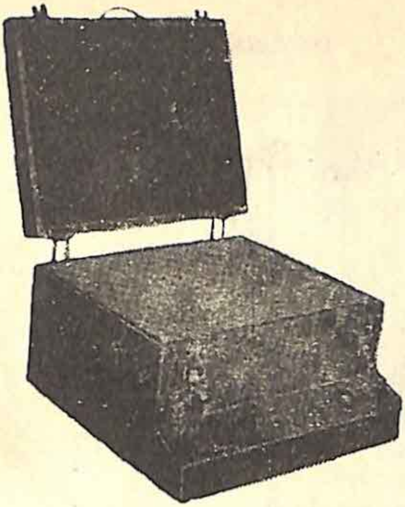
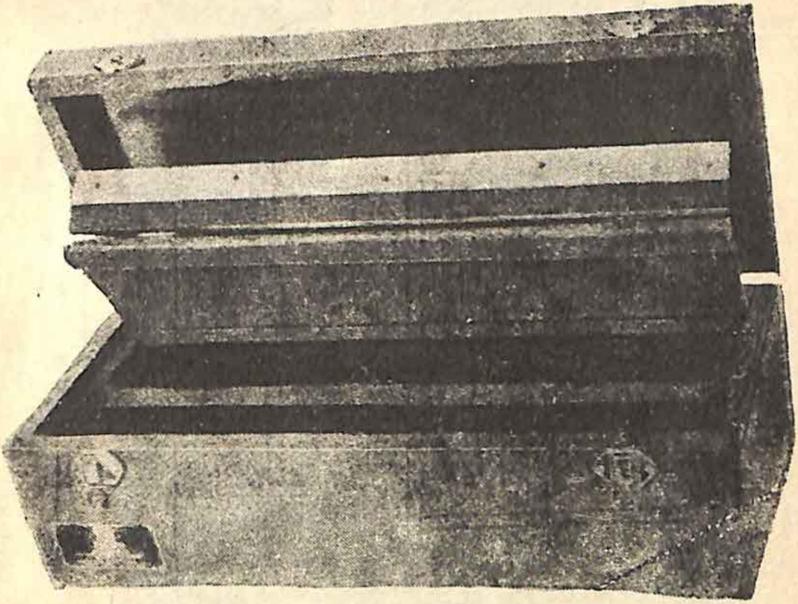


Fig. 6.2
Screen Printing



**AGIL
DOCUMENT CONTACT
PRINTER**

Fig. 6 3



AGIL PAPER CUTTER

A Darkbox paper cutter for
rolls

Fig. 6.4

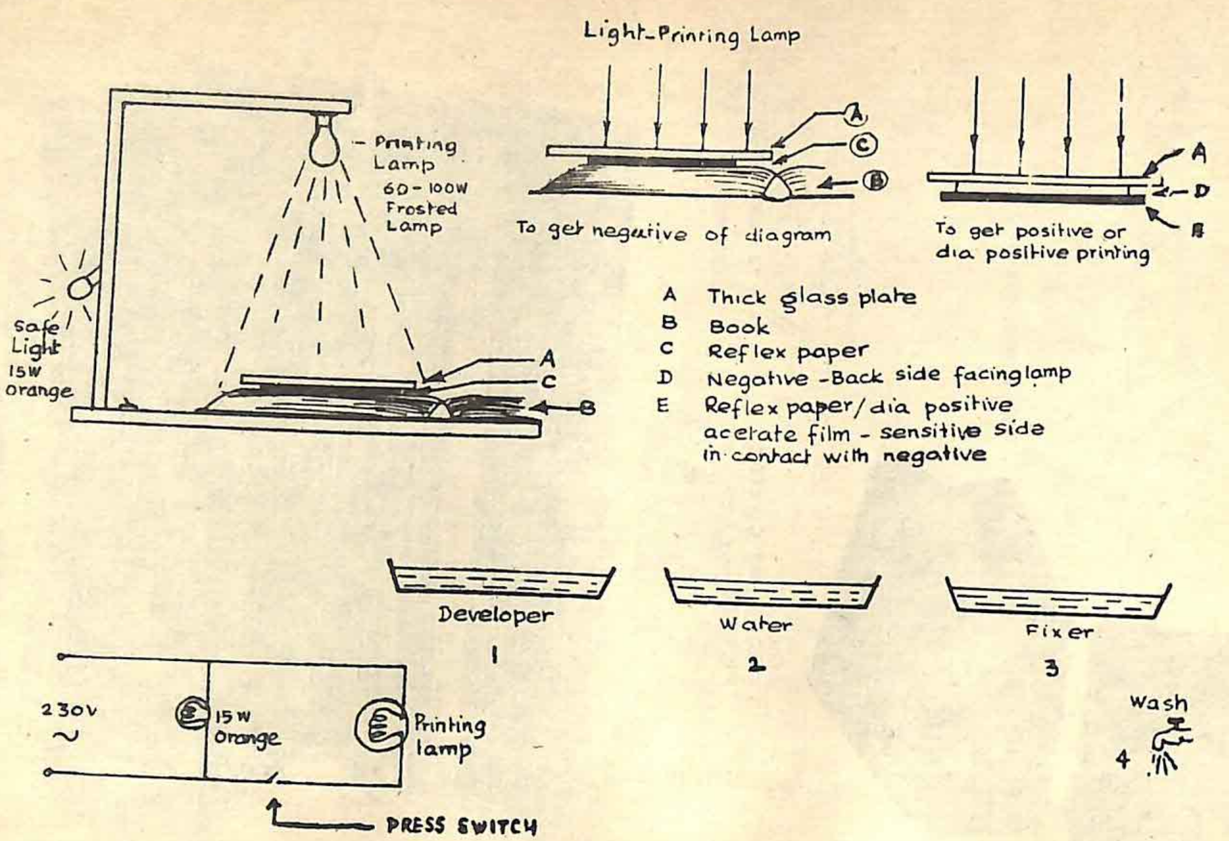


Fig. 6.5
Reflex Printing

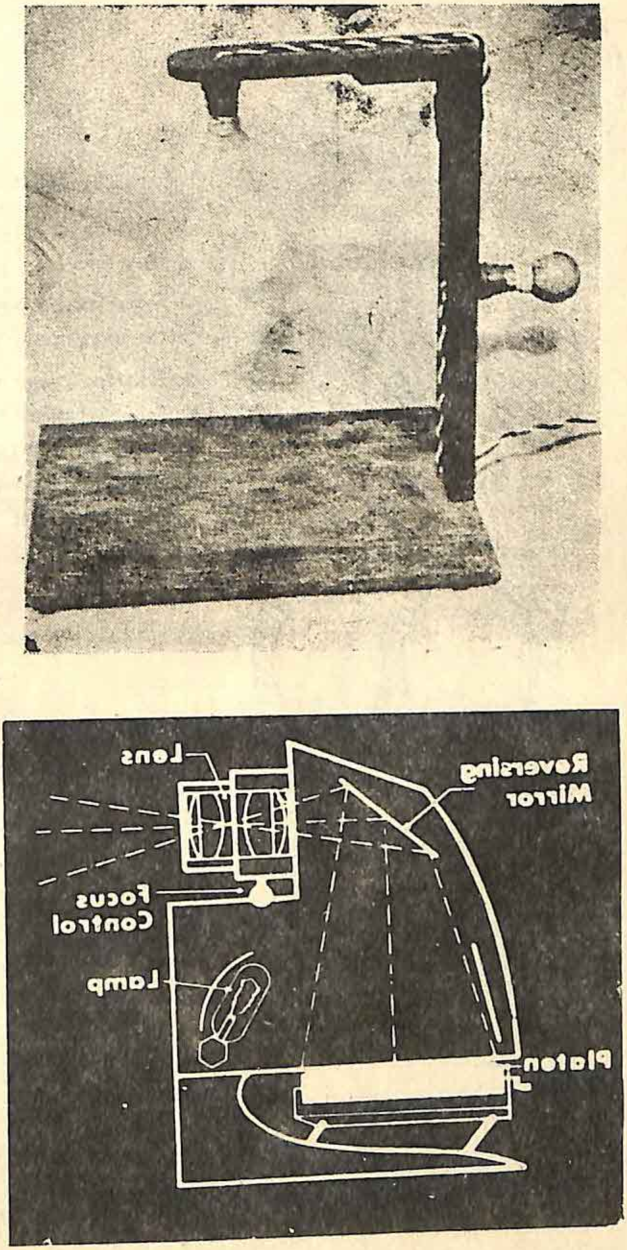


Fig. 6.6
Reflex Printer (Improvised) & Negative

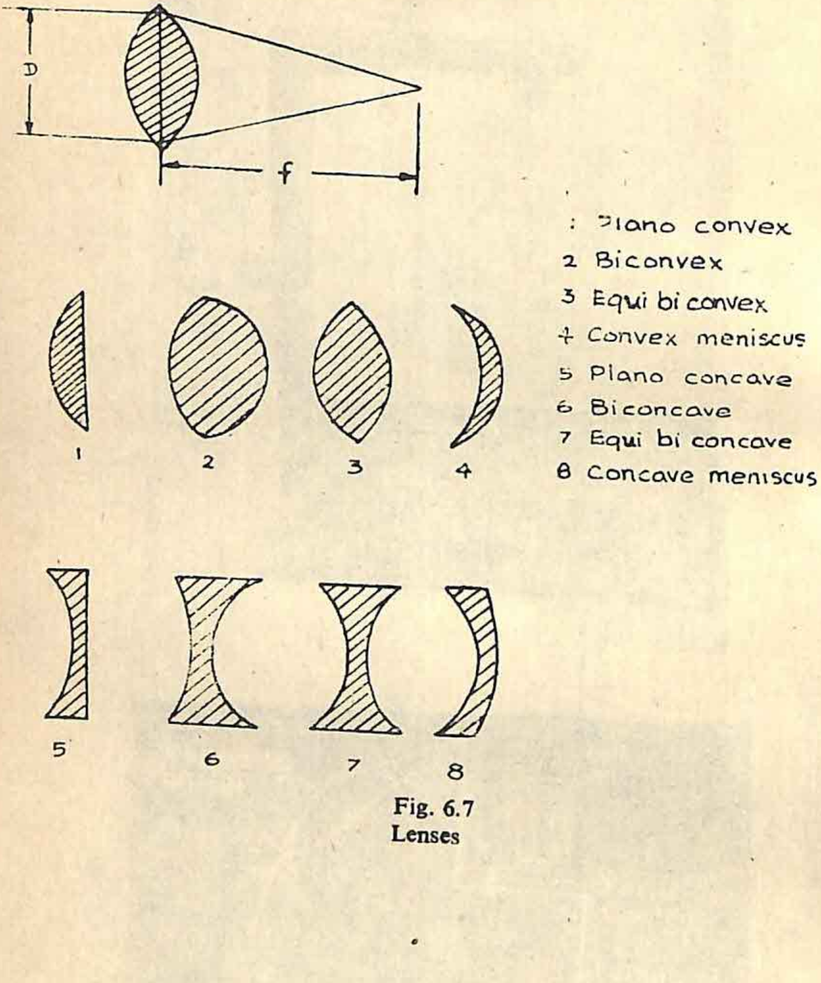
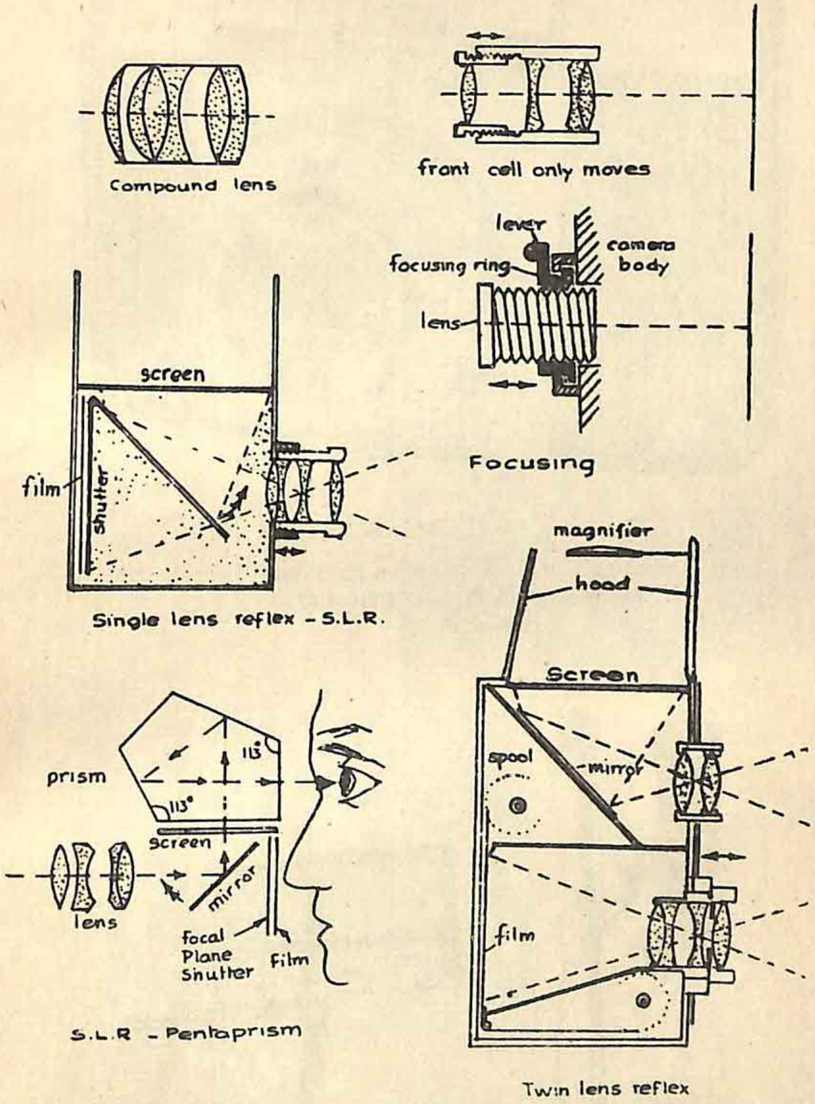


Fig. 6.7
Lenses



Compound lens

front cell only moves

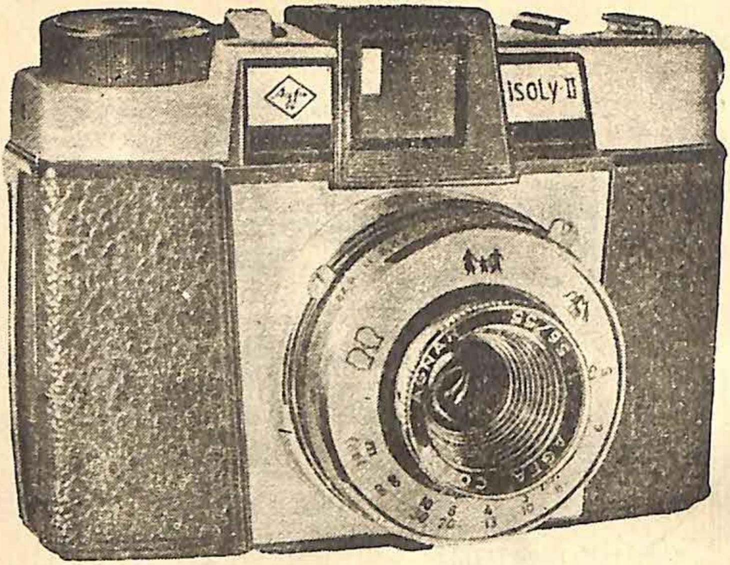
Focusing

Single lens reflex - S.L.R.

S.L.R - Pentaprism

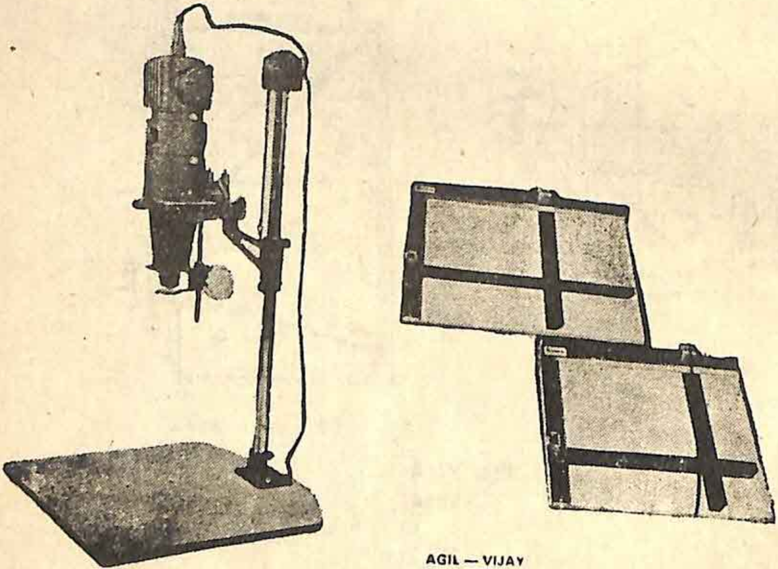
Twin lens reflex

Fig. VI. 8
Cameras



AGFA ISOLY II

16 pictures—4 × 4 cm on 120 Film
(Courtesy : Agfa Gevaert India Ltd.)
Fig. VI. 9



AGIL ENLARGER

AGIL — VIJAY
ENLARGING EASELS

Fig. VI. 10
Enlarger Easels

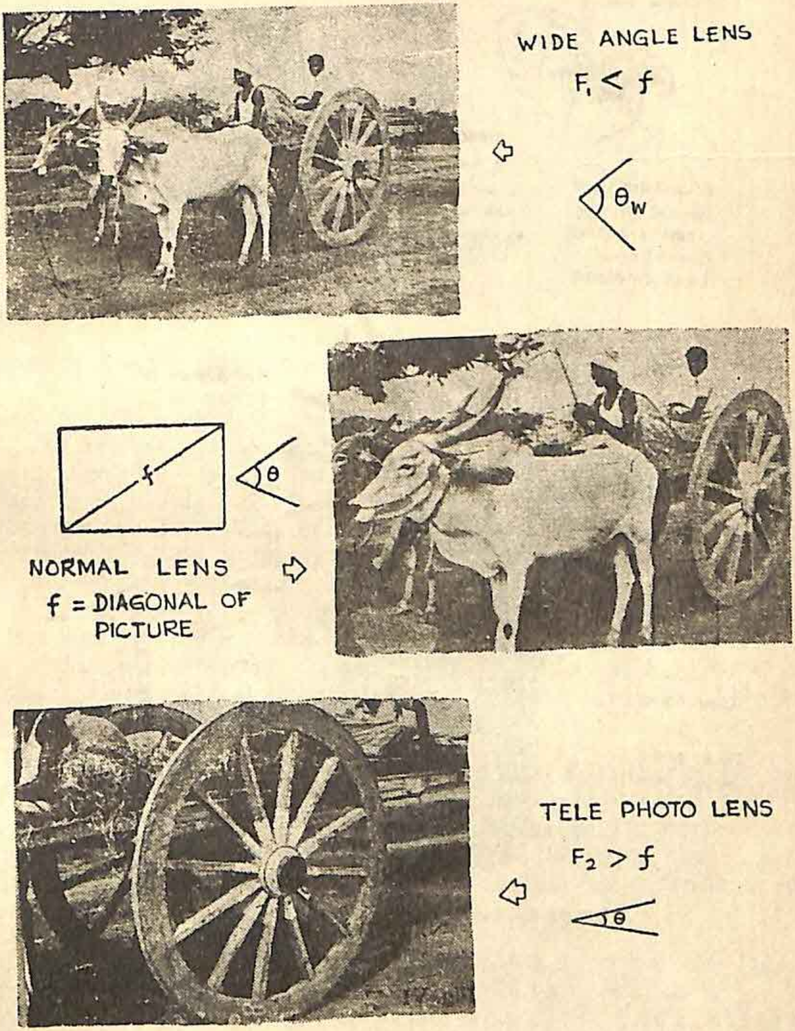
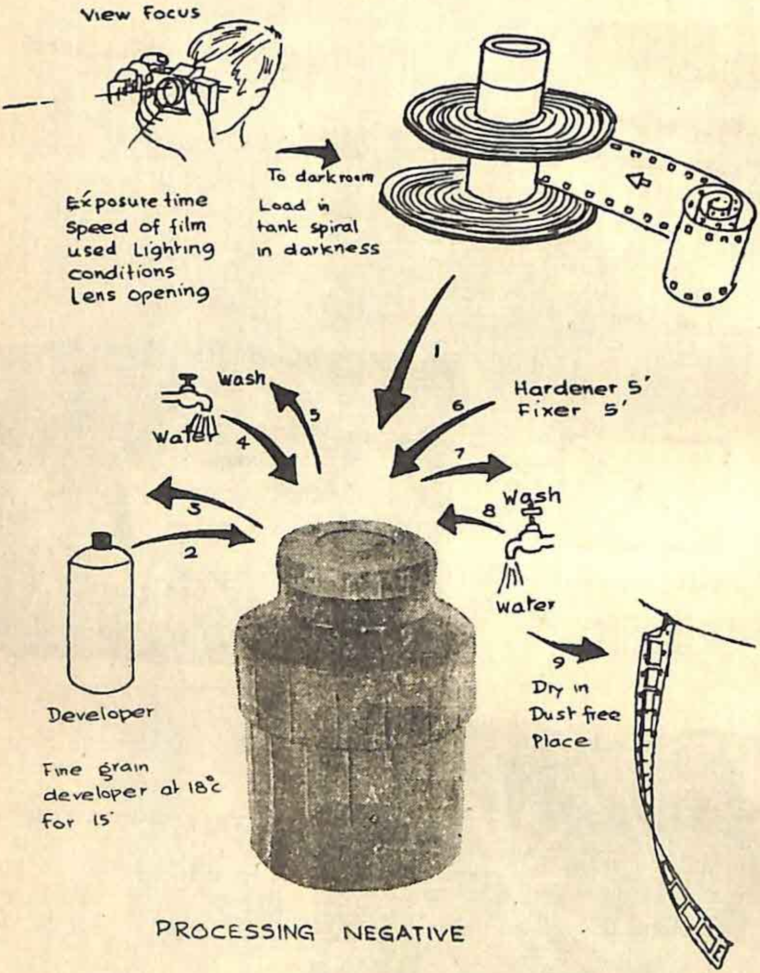


Fig. VI. 11
Interchangeable Lenses



PROCESSING NEGATIVE

Fig. VI. 12

CHAPTER VII

CHALKBOARD

Types and Uses of Chalkboard

Even in the present day when the teacher can make use of visual aids like overhead projector, closed circuit television, etc., the chalkboard, which was called the blackboard, remains as the most commonly used visual aid in the classroom, lecture room and in the laboratory. The use of the chalkboard is highly essential particularly for the teaching of science, mathematics, technology and to a smaller extent in teaching other subjects. The teacher can vitalise teaching through good, clear, well-proportioned illustrations developed in the presence of pupils making good use of colour chalk to emphasise or differentiate specific points, aspects or details. The modern chalkboard is not black but made in different colours but mostly in pleasing green.

Chalkboard provides a very convenient surface where the teacher can develop subject-matter visually in a manner and at a pace to suit the subject and the pupils. The visual message conveyed is more appealing since the same is individual and personal and can be varied to suit the occasion. A picture or chart is not individual. A definite message is contained in it.

The traditional blackboard was made with a large surface fabricated with wooden planks and coated with dull black paint. The board was supported by an easel. The plane of the board was not vertical. This type of blackboard had only limited working area. This type of board is being replaced by wall boards even in schools.

The wall board consists of either the plank board fitted to wall surface or a rectangular portion coated with suitable paint. Chalkboard surface should never be finished with glossy paint.

Modern chalkboards are made up of the following different types of writing surfaces.

1. *Paint Coated Pressed Wood*

Hardboard or any plywood surface finished with dull paint. Special paint is available for coating any surface for use as chalkboard.

2. *Dull Finished Plastic Surface*

Any suitable coloured plastic sheet—P.V.C. or laminated plastic sheets may find special use. For general use such boards may not be suitable because of high cost and further the surface wears out easily. Small boards may be used and writing may be done with chinagraph pencil (different colours) or felt pens with water soluble colours (water colour markers).

3. *Vitreous Coated Steel Surface*

Similar in construction to the tin slates available for school children, steel surfaces are available in small size of 2″ × 3″. Large sizes are not usually made as it will also be necessary to back the surface to keep it plane by wood. A vitreous coated steel board may be used also as a *magnetic board.* White boards are being used in other countries. Writing on the same could be done with chinagraph pencil or felt marker with water soluble colour.

4. *Ground Glass Board*

Ground glass board is the ideal board for the modern classroom. Ground glassboard of very large area can easily be prepared and fixed to wall. The construction is easy and very little effort is necessary to write on the same. It can be made in a variety of colours. The most important aspect to be considered is that there is no coating of any material on writing surface to wear out. The writing surface is ground glass. There are very few substances harder than glass and chalk is perhaps one of the soft substances. The thickness of glass plate used in preparation will depend upon the size of the board. The board should be properly fixed and the glass plate suitably backed with plane wooden surface so that any portion will not be strained due to pressure caused by writing. $\frac{1}{8}$″ glass plates for small boards of size 18″ × 24″ to $\frac{1}{4}$″, $\frac{1}{2}$″ or $\frac{3}{4}$″ plates to wall boards of size 3′ × 6′ or 4′ × 8′ will be necessary.

Glass plate is transparent. The large sheet is laid on the ground preferably on sheets of old newspaper spread evenly. The top surface is ground, using a grinding material and rubbing with rotary movement by a small glass plate applying light pressure with the grinding material well moistened to the consistency of a thin watery paste between. The ideal grinding material is fine carborandum (silicon carbide) or fine corundum emery powder (aluminium oxide). Fine sand can also be used; but the process will take more time. The surface should be kept moist by sprinkling water. The entire surface is uniformly ground. The glass plate would have become translucent. Only one side of the glass plate should be ground. The back surface is painted with good quality paint of the required colour.

Use of Colour Chalk

On different coloured chalkboards specific colour chalks could be used for maximum contrast.

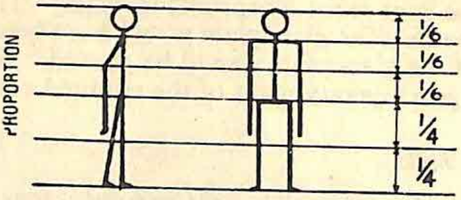
1. Green chalkboard — White or yellow chalk
2. Grey — Yellow
3. Red — Green, yellow
4. Orange — Blue or light green
5. Yellow — Blue
6. Rose — Purple, dark blue
7. Black — Any colour

On glass and plastic boards, felt pens could be used instead of chalk but special cleaning fluid should be used for wiping. Barium sulphate chalk will be more soft. Writings on chalkboard should be erased using a dry duster made of any type of cloth or felt.

The chalkboard should be so positioned that the surface is well lighted and the entire surface will be in full view of any pupil seated in the last row and any teacher of average height will be able to reach any portion of the board easily without any strain. A rectangular box is fitted at the bottom of the board to hold the chalk pieces and duster. Any drawing or picture developed in the presence of the pupils will be more attractive than the same drawn previously.

Use of Chalkboard

Chalkboard is an excellent supplement to other teaching aids. As a "point clincher" the chalkboard is unequalled. The important points of a subject or problem may be driven home with a piece of chalk and a chalkboard. The chalkboard can be used for writing assignments, spelling lists, definitions, outlines and summaries. Facts, ideas and processes can often be illustrated with the help of drawings, sketches and other visual symbols. Spelling words may be written on the board and difficult parts noted by special underlining. Stick figures in proper proportions may be used while representing human forms on the chalkboard.



Some Hints for using the Chalkboard

The chalkboard is similar to a store window display. Everyone knows that an over-crowded, dirty and untidy store window display has little value as compared to one that is clean and neat and displays a few well chosen items which secure the attention of the public. The following rules for using the chalkboard should definitely increase its effectiveness as a visual aid.

1. Do not crowd the chalkboard with too much matter. A few important points make a vivid impression. Constant practice and imagination are necessary for effective use of chalkboard.
2. Make the material simple. Brief precise statements are more effective than long sentences.
3. Plan your work on the chalkboard in advance. Keep the layouts in your preparation sheet for guidance.
4. Gather everything you need for the chalkboard before the group meets. (Chalk—various colours, ruler, eraser, any necessary template etc.)
5. Check lighting conditions. Chalkboard glare should be avoided.
6. Any writing on the board should be large to be visible at a distance, neat to be easily legible. Any diagram drawn should be large; colour chalks should be used only to emphasise or differentiate.
7. Erase all unrelated material. Other work on the chalkboard distracts attention.
8. Keep the chalkboard clean. A dirty chalkboard has the same effect as a dirty window.
9. While writing or developing a picture, it is necessary, desirable and essential that you *should talk or narrate* what is being done.

10. Prepare complicated chalkboard layouts before the group meets. A template may be used for drawing. Templates may be made up of plywood or any laminated sheet with fret saw. They are useful for drawing neat diagrams and when recurring patterns occur in the diagram.

Summary of Effective Use of Blackboard

- B Be kind and Use me.
- L Layout the PLAN in Advance
- A Arrangement of Blackboard
  - Check LAG
    - L — Light
    - A — Angle
    - G — Glare
- C Check CERCA
  - C — Chalk of all colours
  - E — Eraser
  - R — Ruler
  - C — Cane (pointer)
  - A — Any other (templates etc.)
- K Keep it clean—(neat, orderly, black)
- B Be judicious
- O Order—SOS (stand on side)
- A Attraction by CUP
  - C — Colour, capital letters
  - U — Underline
  - P — Pointer
- R Writing with a BRUSH
  - B — Bright
  - R — Readable
  - U — Uniform
  - S — Straight
  - H — Horizontal
- D Drawing with a PEN
  - P — Purposeful
  - E — Easy
  - N — Neat

Chalk Holding and Stroke Technique — Practical Hints

1. Hold the chalk between the thumb and the fingers with the non-working end of the chalk pointing to the palm of the hand. Present the chalk to the board at a low angle. The strokes must be firm, not feathery, whether they be faint or heavy in intensity.

Develop the habit of slightly rotating the chalk as the stroke proceeds, and of changing to a new face of the chalk face for a new stroke or word.

2. *Stance :* Stand back so that the elbow is slightly bent, yet the reach to the board is easy. Start by working in front of the board, you will gradually learn to work without standing directly in front as this would obstruct the view of pupils.

3. *Exercises on Straight Strokes :* Start with vertical lines. Try an exercise of lines of varied intensity. Try an exercise in broken lines. Repeat all the above exercises for horizontal strokes. Repeat for diagonal strokes. Try an exercise in joining points. Place the chalk piece flatwise and draw some 'mass' strokes which are sometimes required. To draw two parallel lines close together, two pieces of chalk may be held, when making the stroke. Try a few samples of holding more than one piece of chalk.

4. *Curved Stroke :* Small circles are formed by wrist work and larger ones by a combination of elbow and shoulder movement. Do not try to mould these curved strokes bit by bit. Try stroke exercises and then plenty of circles of different sizes. Try free curve exercises. Try exercises combining straight strokes and curved strokes. Try exercises for straight lines and circles. Try exercises for free curve strokes. Pay special attention to proportion and to quality of line work.

5. *Writing* : The qualities required in blackboard writing are legibility and speed and beauty, in this order. In developing legibility consider the following aspects : (a) style, (b) letter shape, (c) size, and (d) spacing. Speed is essential for good co-ordination of blackboard work and oral exposition but not at the price of legibility, "Little and often" is a good rule when compiling blackboard work.

6. *Printing on Board with Chalk :* Though printing is slower than writing it embodies a great clarity and aesthetic appeal. Keep it, threfore, for conventional usage, for headings and for emphasis. Develop a simple style of good form for both upper and lower case letters and for numerals. Occasionally for notices, a larger or a more ornate letter is required. Try exercise about 4″ tall with the thickness strokes added after each letter is formed. The advantages of this style are quickness and simplicity. Sharpen the chalk to a chisel point and try exercises for single stroke shapes and for another form of large lettering. The same effect can be obtained by using a piece of chalk ⅜″ flatwise for letters about 4″ tall. Try double lettering by holding two pieces of chalk. Teachers in the artistic trades should develop the technique of chalk lettering to a higher level. It is convenient to sharpen the chalk.

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CHAPTER VIII

NON-PROJECTED AIDS

Graphic Aids

Graphic aids are the form of visuals that are represented on plane surface. The subject-matter areas that are represented in graphic aids are in an abridged and easily-understandable form. They convey meaning mainly through relatively conventionalised symbols that are nearer to reality perceptually than verbal symbols. They secure the attention of the pupils by their attractive format, and simplicity of lay-out. They convey the expected message by combination of visual and pictorial messages made meaningful by suitable captions. Pictures and words blended in harmony deliver the required information. The idea conveyed by any graphic aid should be a single concept. The layout and words should not be complicated so as to puzzle the viewer and make him lose interest in the same. The statement "one good visual which can secure and maintain attention and educate the viewer in the desired area is worth a thousand words" is quite correct. Graphics could be truly considered as the shorthand language of the idea presented. Criteria for good graphics are that they should be simple, bold, legible, brief and have adequate margins.

Graphics are only two-dimensional and should be carefully planned to offset the limitation. A graphic aid by eliminating non-essentials and by using bold symbolic representations with attractive portrayal should be able to create interest and secure the attention of the pupils. Since the message to be conveyed pertains to a single concept and hence brief, the viewer will not get perplexed on being exposed to the visual but will try to read and understand what is implied (visuals and words).

Graphic aids could easily be prepared by any teacher using simple materials that are easily available and could be stored for future use. Making graphics should form an integral part of the teacher's preparation for teaching.

Almost any material involving illustrations is basically graphic in nature. There can be an infinite variety of graphic materials. It is difficult to define a rigid list of these materials. However through common usage, the principal categories of graphic aids are described below.

Graphs

Line graphs, bar graphs, pictorial graphs and sector (pie) graphs are the different types of graphical representations. The nature of variation of two dependent quantities could be very easily presented by graphical representation. Interpretation of graphs is easy and very quick. Correct inferences could be drawn with ease. Pictographs are graphical representations which use simplified representational figures.

Diagrams

Diagrams could be used to explain many facts easily by using a variety of symbols and labels. They can be truly considered as brief visual synopses of facts to be presented. Diagrams can explain facts more easily than charts. Technical fields like engineering rely heavily on diagrams to communicate detailed precise information (blue prints).

Posters

Poster is a bold basic representation in striking colour of an idea or concept in an attractive form. Poster catches the eye and makes the viewer go through the message conveyed. The visual design is dramatic and hence dynamic in appeal. Posters are used widely in all walks of life, to convey forcibly the desired information to the layman. Good posters are simple as well as striking. Schools can use professionally prepared posters for occasions like "wild life week," "vanamahotsava" etc., and they themselves may prepare posters creatively for specific needs.

Maps

A map is accurate representation on a plane surface in the form of a diagram drawn to scale, the details of boundaries of continents, countries etc. Geographical details like location of mountains, rivers, altitude of a place, contours of the earth surface and important locations can also be represented accurately with reference to a convenient scale with suitable colour scheme.

Comics

A comic strip is a form of cartooning depicting a story ir sequence. The events are arranged in the proper order in an attractive pictorial form appealing much to lower age group.

Cartoons

A cartoon is a metaphorical presentation in the form of a picture or a sketch. It vigorously presents and dramatises humour, satire, caricature or exaggeration about an idea, a person or a situation. By the humorous presentation, often exaggerating on any characteristic visual aspect it attracts the attention of the viewer. Cartoon like the poster is universal in appeal and conveys only one idea.

Illustrations (*Flat Pictures*)

Illustrations may be hand-drawn, photographic reproductions, lithographic reproductions which are self explanatory. Good picture illustrations should have good picture quality, good composition, good contrast and sharpness, effective colour and should communicate the idea clearly. They are complete by themselves and do not require any lengthy explanation. *Flat Pictures* are used generally as illustrations. These are a still opaque representation of a scene or object. Such pictures cost less, are readily available and can easily be made and used; but often they are of small size, lack depth and motion.

Charts

Any visual information developed on the chalkboard by the teacher in the presence of pupils is bound to be most effective. The effectiveness could be further increased by the teacher making judicious use of chalk pieces of different colours to stress specific aspects. This may not be possible because of practical reasons. The picture to be drawn may not be simple and may have too many details and hence much time would be wasted in drawing them on the chalkboard. Further, all teachers may not have sufficient skill to draw presentable pictures or diagrams. While a diagram is a condensed drawing consisting of lines and symbols which represent the object or process, a chart is a combination of pictorial, graphic, numerical or verbal material which presents a clear usual summary. On such occasions a chart is much helpful and handy to the teacher. The teacher can prepare the chart whenever he finds it convenient. He can make use of the drawing board, minidrafter, drawing instrument box and other necessary materials. If necessary he may get the services of an artist to prepare the chart. The most commonly used types of charts include outline charts, tabular charts, flow charts and organisation charts.

If suitable charts are available the teacher could make use of them during teaching. This will result in considerable saving of time. The same chart could be used over a number of years. A good collection of charts in an institution should help the teacher considerably. *Tree charts*, *Time line charts*, *Technical diagrams* and *Process diagrams* are also commonly used in classrooms.

Readymade charts are available for use in teaching in almost all areas in all subjects. But it is not difficult for any teacher to prepare a chart. In fact a teacher would find a chart prepared by him incorporating his own ideas and lines of approach of the specific topic more useful to him. When a chart is used for teaching it is essential for all pupils to focus their attention on any specific aspect in the chart pointed by the teacher. Hence the chart should be large, every detail depicted should be visible to every pupil in the class wherever he is sitting. The chart should not contain too minute details or too much written matter making it necessary for any observer to come near and see. Simple charts with a neat professional appearance can be made in minutes with coloured paper, charting tapes and adhesive letters. Charts are also used to create suitable environment in the classroom, laboratory and workshop. Such charts called 'display charts' need not be big and may contain more written and pictorial information. Each chart should display information only about one specific area in a subject. During times when there is no activity in the room pupils could go near the chart and study its contents. Such display charts will provide useful visual material for the pupils when they are not engaged otherwise.

Flip Charts : A series of charts containing visual information about the same area of knowledge, e.g., internal combustion engines may be prepared and the same can be arranged one above the other in the proper series and shown.

Flow Charts : These may contain information about organisation of a government manufacturing process, e.g., cement manufacture. Charts may contain details of construction of specific equipments and their functions. Such flow charts show the functional relationship between the different aspects or parts of the unit, process, etc.

It is desirable for a teaching chart to contain minimum written matter. A chart should not appear as a page from a book. Graphs are necessary in the instructional programme as a means of breaking down cold statistics into a language that can be easily understood by the pupil.

Types of graph that can find a place in a chart are bar diagram (graph), sector diagram (divided circle graph) or line graph.

Material Required for the Preparation of Charts

1. White drawing paper—white cartridge paper.
2. Black cartridge paper.

3. Coloured cardboard.
4. Pencil—drawing H, 2H, HB.
5. Water colour tubes.
6. Poster colours.
7. Camel hair brushes nos. 1—6, flat brushes 1.5 cms., 2 cms.
8. Water proof drawing ink assorted colours.
9. Ruling pen, funnel pen.
10. Script pen nibs-holder.
11. Poster paper—assorted colours.
12. Adhesive paste—gum or fevicol.
13. Felt pen—felt marker—assorted colours.
14. Nylon fibre tip pens—assorted colours.
15. Inks—different colours for felt and nylon tip pens.
16. Self adhesive tape—PVC—assorted colours 1″ wide for edge binding.
17. Letter stencils—(UNO)
18. Stencil cutter—holder.
19. Gauze cloth—(for backing).
20. Wooden reapers ½″ x ½″ cross-section—any light wood.

Purposes of Charts : The following are the specific objectives of using charts.

1. To show relationship by means of facts, figures and statistics.
2. To present materials symbolically.
3. To summarise information.
4. To show continuity in process.
5. To present abstract ideas in visual form.
6. To show development of structures.
7. To create problems and to stimulate thinking.
8. To encourage utilisation of other media of communication.
9. To motivate the student.

The visuals to be depicted are to be pre-planned. A rough sketch may be drawn or a suitable book of diagrams could be selected. Text books, reference books, encyclopaedias, journals, catalogues, etc., may serve as resource materials for preparation of charts.

Planning and Preparing Charts : While preparing a chart the following points shall be kept in mind.

1. Concept or theme to be developed in the chart.
2. Analysis of the main theme in various relationships which are to be developed.
3. Visualisation and illustration of ideas by sketches—rough sketches.
4. Transferring rough sketches to the chart.
5. Colouring, if necessary.
6. Lettering.

Projection tracing is an easy way to make a large chart or diagram from a small illustration. A small picture can be enlarged by using opaque projector. The small book illustration can be placed on the projector and a cardboard can be attached to the wall. The size of projected picture may be adjusted to fit the required area by moving the projector closer to the cardboard (to be smaller) or farther away from the cardboard (to be larger) and focussing as necessary. The main lines of the projected picture may be traced with pencil. After completing the drawing, ink in the lines using pen or felt pen. This is one of the easiest and quickest ways to enlarge a picture. The overhead projector can be used if a transparency or a slide of the original diagram is available. A pantograph also may be used to enlarge or reduce pictures. By using the *squaring* method, a picture can be proportionally enlarged or reduced or even elongated and distorted purposefully.

Before using ink or colour the details to be drawn should be indicated lightly by 2H pencil on white or other light coloured board or if black cartridge paper is used white chinagraph pencil or sharpened chalk could be used.

The lines drawn should be bold and of uniform thickness throughout. Felt marker will be highly suitable.

Large areas can be coloured uniformly by pasting suitable colour, poster paper over which shading could be done using felt pen, nylon tip pen or water colours, etc.

It will be necessary to restrict written matter to minimum or better avoid any written matter. Separate numbers at the end of thin dotted lines parallel to base starting from any specific part will serve as reference to the part. It is not necessary to draw any border; the edge binding PVC tape will serve as a simple border. Ornamental borders will distract attention from chart content.

The matter depicted should be accurate and picture or diagram properly proportioned. The size positioning of caption letters is very important. The visuals should appear balanced.

Preserving Charts

Charts should be carefully stored and preserved for use in future. The chart may be backed up by pasting gauze cloth on the back with adhesive paste. Edges are reinforced by binding with 1" PVC adhesive tape which strengthens the edges and at the same time provides a simple border. Surface may be protected by spraying it with shellac varnish.

Reapers of any light wood of cross-section will make the chart stay flat when hung. For suspension, eyelets with coloured thread may be provided on the top reaper.

When a chart is to be used in a classroom the teacher should make sure that there is provision for hanging the chart at a vantage point. He should also have a pointer to point out specific factors in the chart. Thumbtacks, straight pins, staples, pegboard clips, gummed hangers, paper clips, folded masking tapes may all be used for fastening charts, without damaging them. Charts should be large enough for details to be perceived by all the pupils in the class. Hence the chart could not be used for large groups. For large groups a projected aid would be more suitable.

Maps and Globes

These are not merely fundamental to the study of geography and other subjects but are essential for a whole range of human activities; as interpreting weather, travel, understanding current world events, etc. Maps have innumerable practical value. They are essential to a full understanding of the world, its people and the space around us. Map reading skills have to be developed in pupils so that they are able to readily interpret the information contained on maps.

A map is a flat representation of some or all of the earth surface and a globe is a spherical model of the earth. A good globe should provide correct information about areas, distances, directions and geographical shapes. Even the best flat map cannot achieve accuracy comparable to that of a good globe, as a flat representation of any segment of a spherical surface involves certain unavoidable inaccuracies. Every type of map projection does involve some distortion. The language of maps and globes is largely a language of colours and symbols, standing for locations, boundaries, rivers, routes and other features. Colour helps in legibility as well as beauty in maps and globes. Some symbols on a map look like the things that they are supposed to represent (like international road signs) while others are rather arbitrary and pupils should be trained to interpret them.

Before pupils understand maps, they should understand globes. Globes are of three types, viz., political globes which show the location, boundaries and place details of different countries; physical-political globes which in addition show physical features also; and slated outline globes on which teachers and pupils can write with chalk. This is very useful for direct pupil activity. Globes come in different diameter sizes, the 12″ and 16″ being the most commonly used. The larger size globes have the advantage of readability. Globes differ in the level of information presented, depending upon the educational level for which they are intended. Effective colouring is another important feature to be considered in the selection of globes for classroom use. Globes are available suitably mounted with latitude scales and free floating globes which could be taken out are also available.

Maps enable us to see the complete world at one time, unlike globes which reveal only half of the portion of the observer at a time. A great number and variety of small maps are not available. Any map projection involves some distortion which is unavoidable. Today several suitable kinds of classroom maps are available in what are called minimum-error projections. Wall maps may be physical relief or terrain maps, political maps or special purpose maps showing land use, population, rainfall, etc. Outline maps are also available. Wall maps in the classes should be of adequate size and easily visible so that pupils can see and read the map without difficulty. Map hangers at suitable places should be provided. Legibility and suitability to the grade level for striking effective colour are also necessary, for example a map with too many details will confuse an elementary school pupil. With the overhead projector map outlines drawn on acetate sheets can be projected on the blackboard and details could be added with chalk as the lesson proceeds. Using the overhead projector, overlays could be used adding detail after detail on the projected map. Effective use of maps and globe is based on map reading readiness. This can be developed in the elementary class through extensive observation of the local environment and early experience with globes and global concepts. Pictures and films are to be used to give greater meaning and usual imagery to the features and symbols used in globes. Systematic instruction in geographical concepts enabling pupils to read and interpret globes and maps should be begun at the middle school level as an integral part of the geography and history lessons.

Outdoor laboratory: Adjacent to the school, like ponds and streams, farms and woodlands, rock formations, etc., is of great value in opportunities for environmental studies by pupils and in introducing to pupils principles of ecology and problems of conservation, pollution, etc.

Display Boards

The sterile appearance of the traditional classrooms, libraries and corridors of schools is recently giving way to warm, attractive and flexible surroundings with a wealth of display materials. In well-designed modern school buildings, there are extensive display board spaces in classrooms, display cases located at vantage points, 'teaching walls' made up of folded sliding panels which can be extended to form a partition between one classroom and another and at the same time provide a lot of display space, etc. Even the ceilings are used for star and planet projection and the school grounds include such outdoor learning laboratories as geological paths, erosion study slopes, botanical gardens, soil plots and aquatic areas. All these, rather than the mere bulletin board, come under the general head of display areas. Varied and colourful displays which both communicate information and incite interest and involvement, impart to a school and its classrooms a vitality needed for motivated and purposeful learning.

Study Displays

A study display is an organised visual arrangement of learning materials on a vertical or horizontal surface and is usually designed to present significant information on a given topic. The display may include a wide variety of materials such as diagrams, pictures, photographs, news clippings, three-dimensional objects and specimens. It may be planned by teachers or pupils or both.

Functions of Displays

Displays may be categorised into three main types according to their functions they perform namely, motivational, developmental and summary.

1. Motivational : In the course of a unit of work, a good display can attract and appeal to the learner, stimulate the curiosity and imagination of most of the pupils. A motivational display may be arranged by the teacher.

2. Developmental : As the discussion proceeds, a display may add information for fixing up of ideas in the minds of children. A developmental display should actively involve the student both in planning and execution of the materials.

3. Summary : At the end of the lesson, a display may be used for review and consolidation. This may be arranged either by the pupils or teacher or both.

In general, study displays should be incorporated in a unit of study according to a systematically developed plan. This plan should take into account not only the content but also the interests, abilities and needs of the pupils. The study display can provide a lot of help for the retarded learners who are generally visual-minded. It provides practice for all students in ordering and sequencing of ideas.

In addition to study display, displays may also serve to exhibit reports on student activities, notices of events and regulations. With a little time and effort, they can be made more attractive and effective. Teachers may learn a lot of new ideas from the displays effected in the business world. A successful commercial display must command attention, arouse interest and involve the viewers in such a way as to buy the product. Similarly school displays must be so arranged as to "sell' the idea for a new unit of study.

Space for Display Areas : Many teachers are not aware of the potentialities of the vast space available in the school building which can be used with advantage for display purpose. Displays can be arranged either in two-dimensions or sometimes in three-dimensions as in dioramas. The walls in the classroom, corridors and instructional resource centres can be profitably used for display purpose. Bulletin boards can be erected in these available spaces. Sometimes convertible panels can be installed and these may serve alternately for chalkboards, display or projection screen. Free-standing panels of various sizes can also be purchased or constructed. Joly board (hard pressed cardboard) of suitable size may be covered with inexpensive, loosely woven cloth material. Three-dimensional aids or exhibits can be displayed on tables or in display cases.

Special Display Surfaces : In addition to the kinds of display boards discussed so far, there are other types of specialised display boards. There are such devices as peg boards, hook and loop boards, felt boards, magnetic boards, bulletin boards and chalkboards.

Peg Boards : Peg boards can be used for combining flat and three-dimensional materials, the latter being supported by specially made hooks and clips. Displays can also be positioned at desired points by pegs.

Peg boards are made of tempered masonite having ⅛″ holes punched in a regular pattern of 1″ apart over the entire surface. These boards can be made in suitable size. The specially made hooks can support fairly heavy objects. Peg boards must be mounted ½″ out from the mounting surface.

Hook and Loop Boards : These are intended to suspend heavy three-dimensional objects as well as flat materials. The surface of the board is made up of a special nylon fabric that consists of thousands of tiny but very strong loops. An adhesive-backed patch on which comparable numbers of tiny hooks are woven is affixed to the object to be displayed and the object is then pressed onto the board surface. Though the supporting strength of the hook and loop board is quite remarkable, objects can be easily removed. These boards can also be used as felt boards. But these boards are not at present manufactured in India.

Felt Boards : Felt or flannel materials have a fibre surface and similar materials will adhere to them. Felt boards can be easily made by stretching a suitable size cheap flannel cloth over flat panels of plywood or heavy cardboard. Flat light-weight teaching materials can be cut out from flannel and can be readily used on boards. Pictures can be cut out from books and backed with a small bit of rough sand paper. These cut-outs can directly be used over the flannel board.

Although readymade flannel cut-outs are available, it is always easy for the teacher to prepare them for his class use. The chemistry teacher may find the felt boards useful in explaining molecular structure, the meaning of valency, or formula development. The physical education teacher can use it for demonstrating football play and marching formation.

Magnetic Boards : A magnetic display will be useful to show the relative movements between elements of visuals. A magnetic chalk board becomes more versatile due to the additional facility of visuals that could be made using chalk. A sheet of iron (G.I. or M.S.) that attracts a piece of magnet can be used for magnetic board. Steel-backed chalkboards specially provide the added utility of a surface that can be used either for chalkboard or magnetic board or both in combination can be installed. Small, ceramic magnets can be fixed to the back of the display cut-outs by fevicol.

Pockets of thin sheets may be pasted at suitable locations on the back of the display. Proper size ceramic magnets could be inserted in pockets, when display is to be used. This will enable use of several displays without purchasing large number of magnets.

Plastigraph Board : Any smooth polished surface like plate glass, rigid plastic sheet or laminated plastic sheet may be chosen. Thin plastic sheets of different colours cut to required contours may serve as display material.

Chalkboards : Chalkboard is a basic, most widely used and versatile tool of instruction. It is one of the simplest and oldest of visual aids. The effectiveness in the communication of complicated ideas and abstract principles by means of simple and dynamic illustrations made by the teacher on the chalkboard by running a piece of chalk has not been minimised even in these days of sophisticated aids. The magnetic chalkboard opens up a variety of possibilities for its use in the classroom. Any light weight object can be mounted with adhesive on small magnets on steel chalkboards and slid quickly from place to place. Simple diagrams and lines may be supplemented on the magnetic chalkboard with a piece of chalk and erased at will.

A detailed discussion on the use of chalkboard has been made in Chapter VII of this book.

Bulletin Board : The bulletin board as the name implies, is a place for bulletins, news items, announcements, multifarious items and visual displays that are of absorbing interest to the students. It can present dramatic evidence of the nature of pupil and teacher activities.

Planning and Organising Displays

Arranging the materials for a display is a challenging task for a teacher. The idea expressed must be concise and simple in conception and design. The following tips may be found useful for organising displays.

1. *Decide on a purpose :*

   If it is a study display, the purpose must be made very clear—motivational, developmental or summary.

2. *Choose and Illustrate the Headline :*

   It should be large, easy to read from any spot in the room, fairly brief, horizontal, colourful and contrasty.

3. *Arrange and Illustrate the Contents :*

(a) Use illustrative materials that are eye-catching, such as photographs, drawings, charts, maps, graphs, posters, 3-D objects etc.

(b) Compose the materials artistically, keeping in view the basic essentials of balance and continuity.

(c) Highlight the main theme by a catchy device.

4. *Use Colour :*

(a) Colours have functional aspects which heighten the reconstruction of reality and provide strong emotional and psychological effects.

(b) A jumble of colours is worse than none.

Create an accent with pure colours and use shades and tints in the larger areas. Use warm and cool colours for contrast. Warm colours such as red appear closer to the observer than do cool colours such as blue. In general, foregrounds should be warmer than backgrounds.

5. *Arrange the Display :*

   Mount the pictures and articles in pleasing coloured backgrounds in harmony with the rest ;

General informational pictures are best mounted uniformly and arranged together ;

Highlight different areas by labels and titles ;

Questions and short statements arrest attention if placed near pertinent objects or pictures ;

To create a dynamic effect, use coloured strings or ribbons leading from the statement to the pictures or objects placed on projecting devices artistically situated ;

Use paper arrows in contrasting colours to differentiate different areas ;

For an overall artistic appeal, use flower or radial arrangements and abstract designs ;

Simplicity and brevity are keys to good arrangement.

Provide for viewer involvement if possible, particularly in exhibits ;

Limitations of Displays

Good displays take considerable time and effort to do well. Like any other medium, displays may be overdone and hence may lose their freshness and appeal. Sometimes displays may become cluttered and lose their effectiveness. Further displays made in the classroom may distract the attention of the students when other activities are going on.

Picture Mounting

Worthwhile pictures can be preserved for future use by suitably mounting them on a backing surface. The usual way of fixing a picture is to make use of gum or rubber cement on the backing surface and placing the picture on it and pressing it uniformly. In some cases, the rubber cement spoils the picture itself. Hence for permanent mounting, *dry mounting* process could be adopted. Dry mount tissue can be obtained in rolls from the photographic stores. Suitable piece of tissue can be trimmed to picture size. The picture, trimmed tissue backing is placed on the mounting material and covered with a piece of plain white paper. By applying a heated iron, the picture fastens firmly to the mounting.

Models

The use of models for teaching purpose should definitely be highly effective. Models are concrete objects, some considerably larger than the real object, some small replicas of objects which are too large to be seen as a whole, mostly three-dimensional, or sectional to explain clearly the structure or function of the original, and in many cases working scale models of the original where the specific action of the original is duplicated and could be explained easily. Models offer a kind of short-cut or substitute for the real things and sometimes models can be more effective than reality. An object is a real thing ; but a model is just a recognisable three-dimensional representation of it. *Specimens* are objects that are representative of a class or group of similar objects.

Any concrete object shown to pupils will enable them to have a correct concept of the object and since the model is a replica of the original they will have a clear concept of the structure and mode of working of the original.

Pupils handling working models or teachers using good models can achieve results as much as pupils sharing direct experience. A realistic model in specific instances could be used to greater advantage than the real object.

In many cases, it will be more practicable to use a model.

Models (a) enlarged scale models
(b) reduced scale models

Models (a) three dimensional
(b) sectional models
(c) x-ray models

Models (a) static models
(b) working models

Models (a) as isolated entities
(b) as an integrated unit in a miniature set up

Diorama ; Static; Animated

It should be possible using the model to easily explain the structure and function and working of the original.

The model should not be made of fragile material. Delicate specimens such as moths, insects etc., if embedded in clear plastic can be handled without risk of damage. The construction should be simple.

Purposes of Models in Instruction :

(a) Models simplify reality. As they are three dimensional they evoke greater interest.

(b) Models concretise abstract concepts. They simplify complex objects and accent important features with colour and texture.

(c) Models are made of compact dimensions so they could be used in the classroom for teaching. They enable us to reduce or enlarge objects to an observable size.

(d) It may not be possible or even practicable to make pupils see the whole of a large industrial unit or even a large machine unit but a small scale model will give the correct concept.

(e) A large process could be easily demonstrated by a model as they provide interior views of objects and machines. (e.g., takeapart man)

(f) Preparation of models could form a topic for project work. It is essential to create interest in creative activity in pupils. Ideal and the most natural way of creating this interest in pupils is to make them construct models—simple paper or clay or plasticene models at early stages to highly sophisticated working models fabricated by senior pupils under project work.

A working model will secure immediate attention and will serve as motivation. Interest stimulated could be utilised to fullest advantage. Models should be used only if it is not possible to get real objects to the classroom or when the real object would not be helpful to give a better explanation.

Construction kits--meccano kits, dynam kits etc., will definitely stimulate the pupils to construction activities. Any pupil constructing a model will definitely learn more than what he will learn if exposed to a similar model by the teacher because of the direct experience involved. Models which can be dissembled and assembled by pupils have enormous learning value.

Materials for Preparation of Models

Cardboard—Cardboards of suitable thickness can easily be cut, desired shapes could be formed, pasted and given a better look by coloured paper.

Plastic materials—Clay, bees wax and plasticene (available in several colours) could be moulded easily to desired shape and models prepared.

Easily workable materials—Thermocole could be easily cut with hot wire, bound together with fevicol, finished with sand paper and coloured with water colours using brush.

Plaster of Paris—Duplicate copies of objects with plaster of paris could be made easily.

Wood—Models could be made with wood—hard wood, light wood and easily workable belsa wood.

Metal—Most working models require metal—in the form of sheets, rods, tubes, angles, wires etc., and of course necessary tools for fabrication are required.

Plastics—Models could be made using plastics which have a good surface finish and could be worked easily with heat and pressure (PVC, Acrylic materials etc.).

Thermocole Models : Thermocole models are used for domestic purposes and could be used to prepare static and, to a certain extent working models. Thermocole is available in half sq. mt. sheets. Thermocole could be easily cut with a knife or an electrically heated wire. A thermocole cutter could be improvised easily using a step-down transformer. Surface finish could be effected using sand paper.

Only poster colours, distemper (water soluble) could be used to paint thermocoles. (Note : enamel or plastic emulsion paint should not be used on thermocole. The model will get shrunk if they are used).

Mock-Ups: When the direct first-hand experience is either impractical or impossible, mock-ups can be used. A mock-up may be defined as 'an operating model, usually at full scale, designed to be worked with directly by the learner for specific training or analysis. 'Mock-up is an imitation of a real thing. Some elements of the real thing may be purposely eliminated in order to focus attention on others. Mock-ups are very useful in giving training in complex skills.

Dioramas : A diorama is a three-dimensional scene in depth incorporating a group of modelled objects and figures in a natural setting. The diorama scene is set up on a small stage with a group of modelled objects kept on the foreground which is blended into a painted realistic background. The objects in a diorama are not made to scale. For representation of depth, objects kept at the background are made considerably smaller, to create an illusion. When colour is used in appropriate ways, diorama has vividness and realism. Dioramas are very effective in the teaching of social and biological sciences.

Note on Working with Acrylic Material for Model Making

Perspex—Acrylic sheet becomes soft and pliable between 165—175°C when it can be formed, bent or twisted. When it cools it retains its shape ;

(a) *Heating* to be *uniform*

(b) Slow cooling avoids setting up of internal stress. For bending a acrylic sheet *strip heater* could be used.

Sawing—Wood and metal saws could be used keeping the pressure light.

When jig saw is used feed should be light. For filing normal double cut metal working files could be used clamping the sheet firmly in a bench vice using jaw clamp for protection from jaw impression.

Drilling—point angle 118°—Coolant, used light oil—sheet should be clamped firmly.

Tapping and screwing—as for metal using lard oil as lubricant.

Turning and milling—high speed, radiused tips, light cuts and slow feed of tools using coolant.

P.V.C. and acrylic sheets can be bent along a line using lime heater. When the material has softened along the desired line, the same could be bent and held in the desired shape till it cools. Any plastic sheet heated to the softening temperature could be formed to suitable shapes, by pressing between dies.

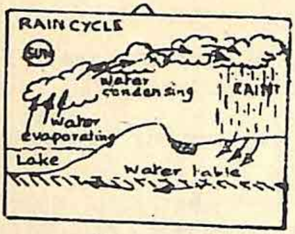
Bonding —(a) Solvents—chloroform, ethylene dichloride trichlerie-thylene and glacial acetic acid. The surfaces to be joined should be clean, smooth and must fit together without gaps. Solvent should be applied to both surfaces and light pressure to be applied till a bond is effected.

(b) Special cements available produce a stronger joint and also tend to fill spaces that may be present between surfaces.

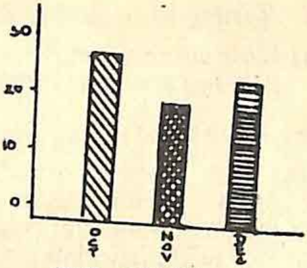
(c) Polyester resin gives a much stronger joint; since the resin gels quite quickly both surfaces to be joined should be covered quickly with the mixture of resin, catalyst and accelerator and press the surfaces together quickly applying light pressure.

Finishing — Larger diameter sanding discs revolving at about 300 rev/min. could be used. The work pressed with light pressure.

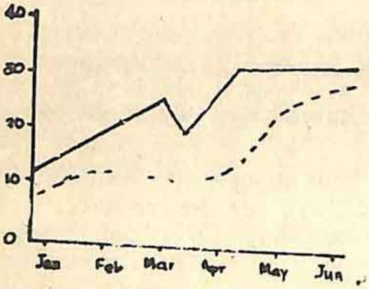
Buffing employing soft calico mops lubricated with mild abrasive—as rouge or tallow will give acrylic a high finish, (localised application for longer intervals will result in heating of materials).



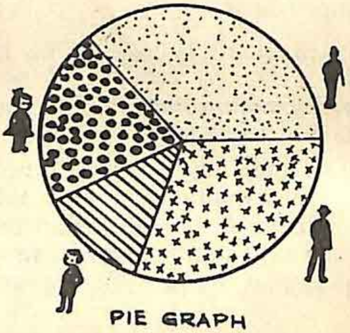
CHART



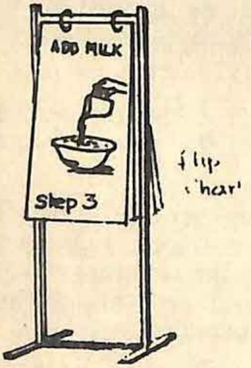
BAR GRAPH

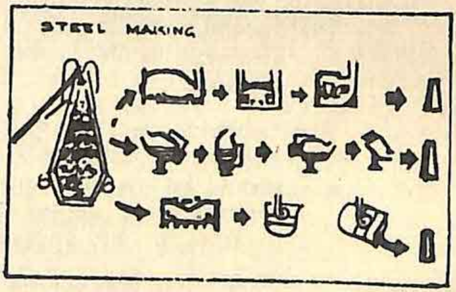


LINE GRAPH



PIE GRAPH





Flow chart

Fig VIII. 1
Graphic Aids

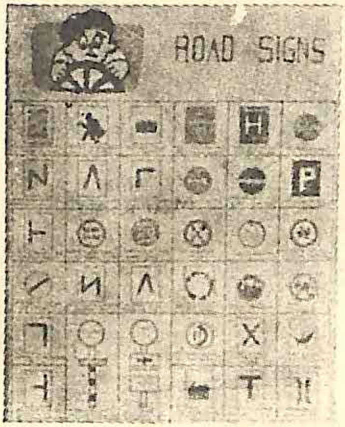


Fig. VIII. 2
Display Chart

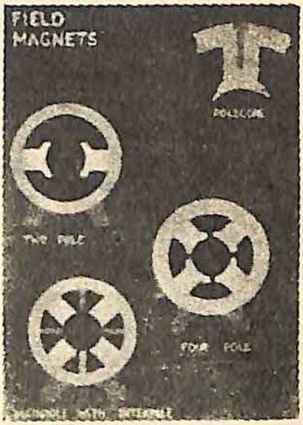


Fig. VIII 3
Display Chart

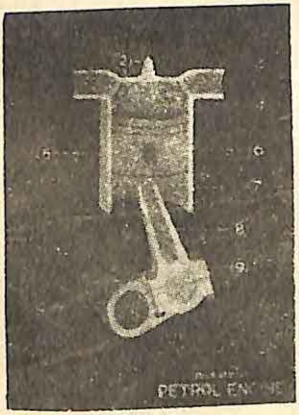


Fig. VIII. 4
Display Chart

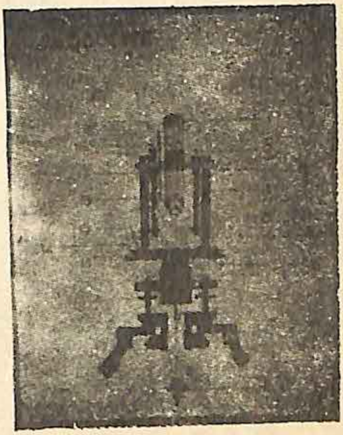


Fig. VIII. 5
Display Chart

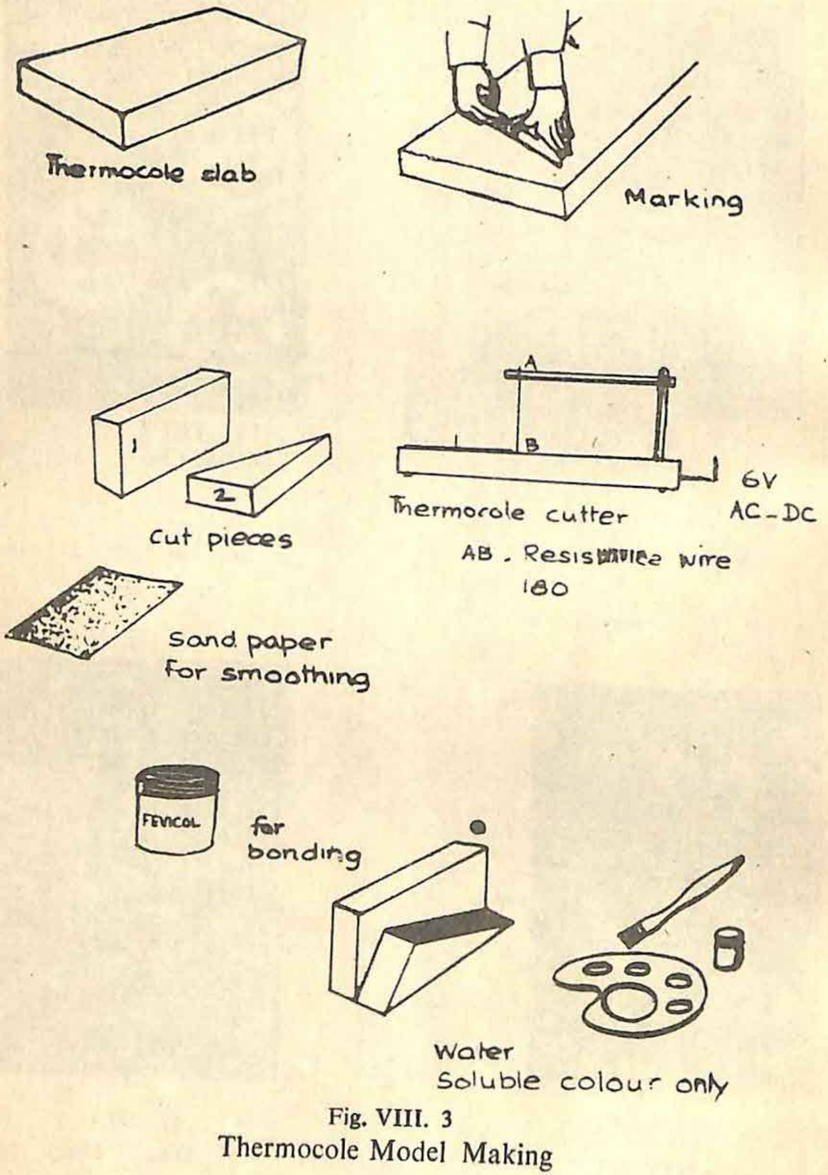


Fig. VIII. 3
Thermocole Model Making

CHAPTER IX

PROJECTED AIDS

When a projected aid is used an enlarged image of the material (slide, filmstrip frame, etc) is projected on a screen kept at a distance from the projector. The room is either totally or partially darkened. A projected aid is bound to be more effective than a non-projected aid since a darkened room reduces distraction and the bright image on the screen secures the attention of the audience easily. Colour will make the aid more attractive ; motion will make the aid more dynamic ; and motion associated with sound will be more effective and attention-compelling than the non-projected aids.

Projected Materials and Projectors

A projected aid is suitable for large groups as well as small groups. The projected image could be made *large and bright* to enable every one in the large group perceive details.

Projected Materials	*Projectors*
1. Book diagrams, flat pictures, thin opaque objects	Episcope or Epi-unit in Epidiascope
2. Slides - (3¼"×3¼")—8.125×8.125 cms. Slides - (3¼"×4") - 8.125×10 cms.	Diascope unit in Epidiascope or Slide Projectors
3. Slides 5×5 cms.	Slide projectors (i) Manually operated (ii) Automatic slide transport with remote control focussing and slide changer
4. Filmstrips	(iii) Filmstrip projector

Single frame 18 mm × 24 mm Double frame 36 mm × 24 mm	(a) Filmstrip Projector manually operated (b) Automatic filmstrip projector for *single frame* filmstrips
5. 16 mm Sound film (optical sound-track)	16 mm sound film projector
6. 8 mm standard film	8 mm standard film projector
7. Super 8 mm film	8 mm super film projector
8. Standard 8 mm loop film cassette	8 mm standard cassette film projector
9. Super 8 mm loop film cassette	8 mm standard super cassette film projector
10. OHP Transparency—single/or overlay Acrylic sheet transparency	Overhead projector
11. Microscope slides/small objects	Micro-projector
12. Small gear profiles etc.	Profile projector
13. 35 mm motion picture sound film	35 mm motion picture projector (sound)
14. 35 mm cinemascope film	35 mm motion picture projector with lens
15. 70 mm film	70 mm film projector (magnetic multiple sound-track)

Power Source for Operation of Projectors

All projection equipments require electric power for operation. Any equipment should be operated only using suitable power source for which the equipment has been designed. Projection equipments are designed at present to operate on 230 volt 50 cycle A.C. Certain equipments like 16 mm projectors are made to be used with 110 volts A.C. In general any sound film projector if designed to operate with 110. Volts AC requires a transformer of suitable capacity to operate it.(step down transformer). The newer models operate with 2V.A.C.

(a) Power supply should be taken only from the three-pin plug base fitted in wall (preferably 3 pin 15 ampere power plug). This will ensure automatic earthing of the body of the projection equipment.

(b) The cable leading power to the switch board should be 3-core flex of good quality and current carrying capacity at least of 10 amperes (7/22 copper wire). The insulation may be PVC or workshop flex would be suitable. The cable should be sufficiently long and of one piece. Connections at either end should be perfect and strands tinned and soldered into one at ends.

(c) The switch board should have at least one in each of 15 amperes 3-pin plug, 5 amperes 3-pin plug, 5 amperes 2-pin plug, lamp holder with 15 watt lamp or neon lamp to indicate if power is available at switch board. The power outlet may have built in switches. An iron clad switch with incorporated fuse will serve as overall control.

(d) Any transformer used should have sufficient capacity to dissipate connected load. Ideal transformer would be a double winding transformer with regulator and voltmeter to indicate output voltage.

(e) A line tester would be useful to find out if there is any possibility of getting a shock on touching the equipment so that the same may be rectified by reversing the plug pin connections.

(f) Power cable should not be taken across the room where there is possibility of any member of the audience having access to it.

(g) Before any equipment is used it should be ensured that proper value fuses have been put at all cut-outs.

(h) If any equipment does not work on connecting to power supply and switching on it may be due to

(i) power supply failure

(ii) blown up fuse in the particular circuit or in the system

(iii) The circuit incomplete due to one of the connecting wires to plug pin becoming loose or broken away at connecting point

(iv) The switch in the equipment not working

(v) The fuse if any in equipment having blown up

(vi) The equipment has been spoiled and hence not working due to faulty components or due to being put to incorrect use.

The Illuminating System in the Projector

The function of the illuminating system in the projection equipment is to illuminate the slide or film or transparency uniformly by a convergent beam of light for optimum brightness of image.

The components in the illumination system are :

(a) Projection lamp
(b) Concave reflector
(c) Condenser lenses
(d) Heat filter to cut out heat rays
(e) Convection or blower cooling to ensure that the temperature of lamp does not rise to the softening point of glass envelope.

Projection Lamp

Projection lamp normally used in projectors is gas filled tubular lamp with Edison screw or Bayonet, single or double contact. The lamp used in older model projectors is similar to the domestic incandescent gas-filled-coiled coil lamp. The filament assembly is plane and is run at higher current density so that the filament attains a temperature only 50°c below the melting point of tungsten. This results in very bright white light necessary for projection but the working life of the lamp will be far less than that of a domestic lamp, e.g., for a 1000 W lamp, the life is about 15 hours, for 750 W about 25 hours, etc. Any surge in voltage or mechanical shock will disrupt the filament and make the lamp unfit for further use.

Many projectors manufactured today have a halogen lamp or quartz iodine lamp. The lamp filament is made of tungsten and contains iodine vapour inside. The quartz iodine lamp gives out more light for the same wattage. The effect of evaporation of tungsten from the filament at a higher temperature is reduced to some extent by iodine vapour which forces the evaporating tungsten molecules back into the filament.

Concave Reflector

The concave reflector is placed behind the filament assembly at a distance equal to radius of curvature of the mirror. The principal axis of the mirror passes normally through the centre of the filament assembly. It is used to reflect back the light radiated from the back of the filament assembly. Usually the reflector is surface silvered or aluminised and should not be touched or rubbed with any material. Certain low voltage lamps have built-in reflectors. Low voltage lamps have the advantage of sturdy filament—e.g., in 12v 60W the filament should be thick enough to glow at 5 amp current through it. Internal reflectors utilise practically all the light emitted by the filament. Further a transformer in the circuit operating the lamp protects the lamp against surges in voltage to a certain extent.

Condenser Lenses

The condenser lenses condense the light on the transparency. In some projectors a heat filter is kept in between the condenser lenses. This filter, which is made of special glass, absorbs the heat and protects the transparency from getting heated excessively. The condenser lenses should be kept clean.

Cooling

Cooling in filmstrip and slide projectors using lower voltage lamps is by convection. In other projectors cooling is by air blown over the lamp by axial or centrifugal blower. In a projector, lamp should not be switched on unless the blower is operating.

Switching order—ON (1) blower (2) lamp
Switching order—OFF (1) lamp (2) blower after some time

Lamps of higher voltage other than that for which the projector has been designed should not be used. Cooling provided will be inadequate and the lamp will explode.

The Projection Lens

The projection lens used in projectors is a converging coated compound lens. A compound lens is made up of two or more single lenses, concave or convex, made of different kinds of optical glass, designed to produce a real image free from aberrations and distortions. All surfaces are coated with a film of magnesium fluoride to increase the percentage of transmitted light. A compound lens should not be dissected. It is not necessary to clean the interior surfaces and elements as there is no possibility of the same getting dirty.

The two surfaces, front and back, should be cleaned by lens cleaning tissue or soft cotton cloth without applying much pressure. The lens surface should not be touched by fingers. If the surface is very dirty with oily deposits, the same could be cleaned using carbon tetrachloride or lens cleaning liquid and later wiped gently dry with soft cloth. Subjecting the lens to prolonged extreme humid conditions may result in the growing of fungus on the surface. Fungs growth cannot be removed. A lens can be protected by keeping the same in a container with a cloth bag containing activated silica gel along with it.

A clean lens will result in clear and brighter pictures.

Zoom lenses are compound lenses of variable focal length and are used in some projectors to make the size of the projected image to a certain extent independent of the throw. (The image may be adjusted to fill the screen).

Projection Optics

The projection axis contains the principal axis of the concave mirror and should pass through the centre of filament assembly, the principal axis of the condenser lens, pass normally through the centre of the transparency, through the principal axis of the elements of compound projection lens and is incident normally at the centre of the screen. The image brilliancy depends on the projection axis, containing all the above elements. This adjustment is called alignment of the projector. If the projection axis is not normal to the projection screen, distortion will result. This is called keystoning. To avoid keystoning for use with overhead projectors, the screen is kept inclined.

The distance between projection lens and screen is called throw (*d*). To get an enlarged image, the film is kept between f and $2f$ of the projection lens. Since f is small compared to d (throw) (v). Magnification is calculated by the formula v/u approximately equal to $d/2f$. Size of the image could be increased by increasing the throw d, or using a projection lens of smaller focal length (f). A larger image will be less bright since the same light is spread over a larger area. A zoom projection lens will enable to a limited extent, fill in the entire screen irrespective of the throw.

Projection Screens

Projection screens are the base on which light from the projectors is incident and the image is formed. For distortionless projection the projection screen should be normal to the projection axis.

There are two types of projection—Front projection and rear projection.

Front Projection

In front projection, the projector and audience are on the same side of the screen. Front projection is used commonly in a darkened environment. It is ideally suited for large audience. The intrinsic brightness of the image depends upon the illuminating power of the projector light source and the amount of light scattered by the screen.

The front projection screen should be :

1. Plane surface.
2. White surface.

3. Should not reflect light incident on it in any specific direction but scatter the same in all directions.
4. Large percentage of light incident should be scattered and only minimum absorbed.

The following surfaces could be used for front projection purposes :

1. A clean plane white-washed wall.
2. Asbestos cement sheet of sufficient area of the plane smooth side painted with non-glossy super white paint and suitably mounted.
3. Plane smooth side of hardboard, plywood or joly board of sufficient area, suitably mounted and painted with non-glossy white paint.
4. Thick white cloth like white drill, gaberdine suspended as indicated, in the figure, avoiding wrinkles.
5. Special screens for wall mounting or on self-supporting stands with provision for rolling the screen inside protective sheath are available.

(a) *Matte Screen* : This screen is ideal for indoors and outdoors. The screen surface when it gets dirty can be washed using soap water with sponge. A matte screen can be viewed over a wide angle. The viewing angle is about 45″. Matte screen is ideal for square rooms so that when the projection axis is parallel to the diagonal of the room, wherever the audience are seated the viewing angle is never greater than 45°

(b) *Beaded Screen* : On the surface of white plastic base, tiny glass beads of diameter about 0.1 mm are spread. The intrinsic brightness of the image formed on a beaded screen is very high. A colour film projected on a beaded screen will be very bright and the colours will be brilliant. The viewing angle for a beaded screen is only 22°. A permanently fitted beaded screen in a long hall will be ideal. Beaded screens should not be used outdoors as the surface when it gets dirty, cannot be cleaned. The screen should be rolled and unrolled very carefully. A sharp fold made on the screen will result in the falling of beads along the line and this line once formed cannot be removed.

(c) *Processed Metallic Surface Screens :* These are special screens of wide viewing angle, with corrugated surface and coated with phosphorescent substances.

A projector deserves a good screen. A beaded screen either portable type on stand or fixed to the wall is ideal. But for general purposes and use in indoors and outdoors, matte screen may be preferred.

Rear Projection

In rear projection, the audience and the projector are separated by the translucent projection screen. Rear projection screen should naturally form a more brilliant image. The light from the projection screen is reflected by a silvered or aluminised mirror surface on to the screen. Reflection by a mirror is necessary to correct lateral inversion.

The projection screen is made up of translucent material—

1. Thin muslin or mull cloth
2. tracing cloth (ideal)
3. thin glass plate finely ground on one side
4. thin clear perspex sheet finely ground on one side.

Rear projection is also called 'day light projection'. If incidence of stray direct light is prevented on the two sides of the screen the room need not be darkened.

Rear projection is ideally suited during exhibition. Projector can be kept in a separate dark room adjoining a verandah. The screen can be fitted to the door. With judicious framing of the screen, the people passing along the verandah can clearly perceive the image on the screen. For micro-projection, rear projection screen is ideal. Most of the Super 8 loop cassette projectors project the image on a rear projection screen reflected by a mirror.

Epidiascope

Epidiascope is a combination of episcope and diascope. With the epidiascope in the epi-position, flat opaque objects can be projected. In dia-position, slides either 3¼″ × 3¼″ or 3¼″ × 4″ can be projected using suitable slide carrier.

In epidiascopes, one 1000 watts lamp or one 500 watts lamp or two 500 watts lamps are used. There is a powerful blower cooling the lamp and directing blast of air on the opaque object to be projected. In spite of the cooling provided, page of any book if exposed for a long time to the intense heat from the lamp or lamps, will become dehydrated brittle and crumble to pieces.

The light that is scattered from the book page is less than 20% and is used to form the image on the screen. Hence in spite of bright light source and wide aperture epi-projection lens, the image formed on the screen will not be bright. Hence during epi-projection, the room should be totally darkened.

It is not advisable to resort to epi-projection for normal classroom teaching. Episcope can be used to enlarge book diagrams for preparation of charts by the teacher.

For dia projection, total darkening is not necessary. The large slides 3¼″×3¼″ or 3¼″×4″ can be produced by hand drawn or using camera or by reflex printing process. As the light rays are transmitted through the transparent slide, the image appears very bright on the screen.

The reflecting mirrors in episcope or epidiascope are surface silvered or surface aluminised and should not be touched on the surface. The projection lenses should be kept covered when not in use to prevent dirt and dust settling on the exposed front surface. Proper cleaning of the lenses and perfect alignment of lamps will ensure better and brighter image. The epidiascope should be kept covered when not in use. It is a heavy equipment and it is desirable that shifting the same from place to place is done carefully. A trolley with castor wheels would be ideal. In some epidiascope, there is provision of a mechanical pointer to point out any specific aspect in the projected object. It will be convenient to have book diagrams either reflex printed or photographed and enlarged. They can be suitably mounted on cardboard and can be projected on the screen, in desired sequence.

Stereo pictures and stereo-slides provide a three dimensional effect to the viewer. The stereo viewer like the 'view-master' takes in a disk with seven matched pairs of scenes taken with a stereo camera. Stereo slides are prepared in pairs from photographs taken with stereo cameras which take 2 pictures simultaneously through 2 lenses that are a few inches apart like the human eyes. Each picture is thus taken from a slightly different angle and when viewed through the 2 eyes at the same time fuse into one giving the impression of depth.

Hand drawn Slides

Any picture or diagram, which will take a long time to draw on chalkboard during the class period can be reproduced on a glass slide and enlarged image of the picture on the slide can be projected on a screen with a slide projector or epidiascope. The classroom need not be completely darkened for slide projection with high wattage projection lamps used in projectors and screens. There can be sufficient illumination in the classroom to enable pupils to copy down the projected diagram and take notes.

The size of the standard lantern slide is 3¼″ square or 3¼×4″. At present 2″ square slide is gradually replacing the 3¼″ slide. The thickness of the standard 3¼ square slide is about ⅛″ being made up of two glass plates held together by a binding strip. Each glass plate is of 1/16″ thick. There are several methods by which slides can be prepared, the best method being the photographic method. The object is photographed and positive printed on a lantern slide plate. 2″ square slides can be projected with the slide carrier availabe with 35 mm filmstrip projector.

The slide on which the picture is reproduced is protected by a similar piece of glass called *cover glass*. The slide and cover glass are bound together at the edges by a piece of paper called *binding strip*. The binding strip is ½″ wide and is usually made of opaque paper. Readymade strip cut to the required dimension, one side gummed are available but any thin opaque paper can be cut to the desired dimension and used, cellotape can also be used. A *mask* of opaque paper (black) or better metal foil is placed between the two glass plates so that only the required area is transparent. It is desirable to restrict the size of the picture within 2¼″ square so that the margin of ½″ is left all around.

A white paper circle is pasted at one corner to serve as *indication* to place the slide in the proper position during projection so that a proper erect image is projected on the screen.

Lantern Slide (Hand-drawn) : Plane glass plate of about 1/16″ thick is cut into 3 squares. The square plates are washed with soap and allowed to dry. There should not be any oily contamination on the surface. The cleaned glass plates should be handled only by the edges. The clean surface should not be touched by fingers. The diagram or picture is reproduced on white paper so that the entire picture is confined within a 2¼″ square. The slide can be placed over the drawn picture and traced easily. There must be minimum amount of description, on the slides. It is always better to reproduce the diagram or picture only. The pupils can be asked to describe or identify any part of the projected picture.

It must be remembered that the slide is to be used for projection and the image on the screen will be very large compared to the size of the picture on the slide. A thick line will be magnified to ugly proportion and will result in an unaesthetic picture. Hence lines drawn on the slide must be thin and colouring must also be fairly dense.

The following are different methods of preparing the slides:

Method I

On the perfectly clean and dry glass plate pictures can be drawn with good quality Indian ink using crowquill pen.

Method II

One face of the glass plate can be ground into a translucent surface by placing it over another thick glass plate, on which some fine carborundum powder is placed along with water, applying even pressure and rubbing with a circular motion. The picture can be reproduced on the ground surface with Indian ink. The diagram can be coloured with water proof drawing ink. This slide can be used to full advantage only if the projector lamp is very powerful. Yet it is a very easy method. Emery powder or very fine sand may also be used. When slides are urgently required, any black lead pencil can be used to draw on ground surface.

Method III

The glass plate can be coated with egg albumin. The coating must be even and can be done by a brush. When the coating has become dry, picture can be drawn with Indian ink with suitable pen. This slide can be coloured with any transparent water colour (Johnson photo tint, or Velex transparent colour or Fuji colour) with fine brush. The density of colouring must be increased in stages and it must be remembered that once a particular density has been built up, it cannot be reduced.

Method IV

Gelatin can be dissolved in hot water. Sufficient gelatin is used so that the solution has the consistency of thin mucilage and can be evenly spread using brush. This is coated over the glass. The subsequent procedure is the same as in the case of albumin coated surface plates. (1 gm gelatin is heated with 25 cc of water till the same is completely dissolved).

Method V

Celluloid film can be dissolved in amyl acetate and the solution is coated evenly over the glass slide. Reproduction of diagrams on the coated surface is done in the same way as in albumin coated surface.

Method VI

The diagram can be drawn on celophane paper with Indian ink. The paper is placed in between two glass plates and bound.

Method VII

With glass marking pencils, diagrams can be drawn on a glass surface which can be projected on the screen. These pencils are available in all colours but markings are opaque. With the glass plate slightly heated, an easy impression can be made. This method can be employed only when there is no time to make other types of slides. It is not possible to draw thin lines with glass marking pencils. Hence it is not desirable to mount such slides as they are not worth keeping permanently.

Method VIII

On a spoiled photographic plate which has been developed and fixed or on a glass plate coated with opaque paint (lamp black suspended in shellock varnish or a thick even coating of Indian ink) free hand drawing is effected with sharp pointed tool (divider leg), the diagram will stand out bright against a black background.

Method IX

The object or picture is photographed and with the help of the negative, a positive print can be made on a photographic lantern slide or diapositive film using the photo enlarger. Book diagrams of suitable size can be reproduced on a reflex printing paper. With the help of the negative, a positive print can be made on a diapositive film. The picture so produced can be suitably framed with the rigid cardboard, mount with window cut over picture area.

Slide Projector

Slides are projected by an instrument equipped with a powerful light source in a lamp house and carriers for holding slides of suitable sizes. It is a simple mechanism and the essential elements in it are the same as in fiimstrip projector. Usually the double slide carrier is fitted in the projector so that when one slide is projected on the screen, a second slide can be kept ready. When the class views the second slide, the first slide can be removed and another inserted in its place. There is a "thumb mark" or guide marker on the upper right hand corner of each slide. Most 2″ x 2″ slide projectors today use drums or cartridges in which many slides can be loaded in proper sequence in advance. The projectors can be operated and focussed by remote controls. It is also possible to record the narration in a tape recorder and the latter may be hooked up to the slide projector in such a way as to give the necessary commentary without the help of the teacher.

Filmstrip Projector

Among the various types of materials available under 'Still Projection', slides and filmstrips are the foremost visual aids. They are of great value in visual teaching situations, especially when motion is of little or no importance for understanding. Although slides and filmstrips are essentially similar, the latter replaces the former in its utility for a variety of reasons. For example, a pack containing a number of glass slides on a particular topic is usually bulky. Further each slide must be put in the slide carrier correctly so as to get an erect image without lateral inversion on the screen. The slides should also be put in correct sequence during projection. These difficulties are avoided in the case of filmstrips.

What is a filmstrip?

A filmstrip is a piece of non-inflammable safety film 35mm wide, varying in length up to about 1 metre. It is a related sequence of transparent still pictures and may contain anything from 10-50 pictures or frames. These pictures may constitute a connected series of drawings, photographs, diagrams or a combination of these and illustrate a single topic, theme or story. Some strips have explanatory titles, but mostly they depend on the teaching notes which accompany each filmstrip. These notes form a guide to the understanding of each frame. Some filmstrips are accompanied by commentary recorded on records or tape. Such a filmstrip is called a 'sound filmstrip'. The record or the tape usually carries the narration and may also include appropriate music and sound effects. Filmstrips may be produced using 35mm black and white or colour film.

Filmstrips can be prepared either in 'single frame' or 'double frame'. In the case of the single frame, the size of each picture or frame is 18 × 24mm and in the case of the latter, the size is 24 × 36 mm. In both the cases, the longer dimensions usually correspond with the horizontal of the picture represented.

The Filmstrip Projector

The filmstrip projector in principle and construction resembles the projection lantern commonly called magic lantern. It has a specially designed lamp, concave reflector to reflect light from the back of the projector lamp, heat filter, condenser frame, rotatable filmstrip carrier and coated compound projection lens. Cooling the lamp is effected by convection current or by air blower. A heat filter is also used to absorb heat radiation from lamp to certain extent. A filmstrip projector is fitted with 110 volts lamp which should be operated in the 250 volts A.C. mains through a step-down transformer. Filmstrip projectors with provision for remote control of transport frame by frame and filmstrip projectors with automatic transport of filmstrip to next frame after a definite interval are also available.

Care and Operation: The general precaution that is to be observed in the operation of any equipment operated by electrical power should also be borne in mind in the case of filmstrip projectors. A filmstrip projector fitted with 6 or 12 volts lamp if connected with

250 volts mains will result in lamp exploding and blowing up of the fuse in the circuit. Blower cooled projectors are usually fitted with A.C. motors and should not be connected with D.C. mains.

The fimstrip carrier may be with glass pressure plates or without glass plates and may be rotated so that the film traverses horizontally or vertically. In the case of single frame filmstrips, the carrier is rotated for vertical traverse of the film and the mask is inserted.

The filmstrip is threaded so that the resulting image on the screen is erect and without lateral inversion. Focussing is done by adjusting the projection lens so that the image is sharply focussed. The film can be advanced frame by frame by turning the knob which pulls the filmstrip.

Prolonged exposure of the film to excessive heat may cause permanent damage to the film. Keeping a frame for more than 1-2 minutes should be avoided. In the case of colour filmstrips, the time should be less.

The care of the projector lies in the proper cleaning of it before each use. The lens and the two glass plates through which the filmstrip passes may be cleaned with a soft camel hair brush. The projector should not be subjected to mechanical vibrations, as it will result in rupture of the filament.

Advantages of Filmstrips

1. Light and easy to transport;
2. Non-fragile and non-inflammable;
3. Moderate cost;
4. Availability of filmstrips dealing with varieties of subjects;
5. Comparatively low cost of the projector;
6. Availability of projector with low voltage lamps or petromax lamps making it possible to use the same even in non-electrified areas;
7. Complete darkening of the room is not absolutely necessary. There may be sufficient light to enable the pupils to take notes.
8. A projected image has greater power to hold attention of the audience, particularly if the room is dark and relatively bright screen catches and holds the eye.
9. Varieties of information may be given incorporating maps, drawings, photographs, etc., in the filmstrip. Although only still pictures are projected, it is possible to secure the attention

of the pupils as in the case of motion film. The teacher can give suitable commentary making use of the guide books or can record the commentary on a tape and replay it during the screening of the filmstrip. Further the pictures can be retained on the screen as long as necessary.

10. With every filmstrip projector a 2″×2″ slide attachment is also provided. The same projector can be used for projecting slides.

Preparation of Filmstrips : Filmstrips can be prepared either by employing photographic methods or by drawing pictures by hand on the film itself. In either case, there are various steps to be followed in the preparation of a filmstrip.

1. Select a suitable topic from the syllabus after considering the possibilities of depicting the subject-matter by drawings, diagrams, photographs, etc.
2. Prepare a detailed script, describing the contents of each frame indicating the method of preparing it i.e., whether by art work or by photograph.
3. Make rough sketches of the figures on the paper so as to serve as guide when final sketches are drawn.
4. Draw the sketches in suitable sizes on white drawing paper with Indian ink or on blackboard with white ink. If the subject chosen requires exact reproduction of the original, then necessary photographs must be taken on the subject and then they must be enlarged to the required size.
5. Arrange the drawings and enlarged photographs according to the script and number them in sequences.
6. Rephotograph in correct sequence of the materials thus arranged using 36mm film camera and prepare the negative.
7. Print positives from the negative prepared above.
8. Prepare the guide book which is to follow the filmstrip explaining the details of each frame. The commentary may even be recorded on a tape and it may be used in combination with the filmstrip. An audible signal like the stroke of a bell recorded with the commentary may indicate when the next frame should be shown. But this kind of recording of the commentary makes the teaching with the filmstrip less flexible.

Using the Filmstrip in Teaching

The first step in teaching with a filmstrip is that the teacher must select the suitable filmstrip which has got specific contributions to make on the topic of the lesson at hand. Then he must become thoroughly familiar with the content. This necessitates reading the accompanying guide book or previewing the filmstrip. The students should then be briefed about the filmstrip and sufficiently motivated by using other aids so that they would be eager to see the filmstrip. As each frame is presented, the teacher should give commentary and explain difficult concepts. If the filmstrip contains titles and explanations, enough time must be allowed for the class to read them. The entire group or the teacher may read aloud. In any case, each frame should be held on the screen long enough for adequate study. Finally evaluation at the end of every programme is quite essential. This may be done through oral questioning or written tests to find out the effectiveness of the filmstrip. The filmstrip may be shown again if necessary.

Although the filmstrip has got several advantages over the other teaching tools, the greatest limitation lies in the fact, that it lacks certain attention-compellin gqualities namely, motion and sound. However the effectiveness of the filmstrip depends in a very large measure upon the skill of the teacher. Now, filmstrips with commentary recorded on discs or tapes are available. The teacher can also tape his comments and play the tape, synchronising it with the frames of the filmstrip.

Camera for Production of Filmstrips

For the production of filmstrips a camera using 35 mm (double perforated film) is required. Normally 35mm cameras could be focussed upto 2-3′. For the preparation of filmstrips it will be necessary to take pictures of diagrams, etc., in books, small objects, etc. The camera should focus at distances even upto 15 cms. Most of the 35mm cameras marketed take pictures 36×24mm and could be used to produce double frame filmstrips.

Certain makes are available which take 24×18mm and could be used to produce single frame filmstrips directly. Even a camera taking 36×24mm pictures could be used to take single frame filmstrips by placing two pictures (enlargements) of aspect ratio 4 : 3 separated by a black strip and photographing in one frame.

A single lens reflex camera S.L.R. (35mm) would be ideal for use to take filmstrip. Focussing range could be brought down even to 15 mm (a) by having extension tube between lens and camera (b) by attaching a supplementary lens, of good quality used for spectacles could be used. +1, +2, +3 lenses would suit the purpose.

The advantage of S.L.R. camera is that the image could be focussed by viewing.

In the case of other types auxiliary method could be used but it is necessary to have a calibration chart for the camera.

A ground glass screen is held with ground surface in the camera focal plane. Shutter is kept open; iris is kept fully open. A supplementary lens is fixed in close contact with front lens using cellotape. A graph sheet with some fine drawings is focussed. The focal plane is kept parallel to the book. The distance marking of camera is set up to lowest marking, 1 metre or 3 feet. The camera is raised slowly till the graph sheet diagram is in focus. The perpendicular distance between supplementary lens front and graph sheet is noted. The area of coverage is also noted. This is repeated for various distance settings of camera lens. The results are tabulated and this could be used for close up photographic work.

The calibration data could be similarly obtained using other lenses. While using it will be necessary to use a stand, improvised to point the centre of picture towards centre of lens and distance from centre of lens to centre of picture and area included from calibration chart. · A small aperture opening will ensure better focussing. At closer distances the difference between distances of centre of field and edge of field to lens centre would be considerable.

A slow film would be better and would give good contrast. A number of lights, frosted bulbs in aluminium spherical reflectors could be used to illuminate the object. Exposure time could be accurately arrived at by trying different exposures and comparing after developing and fixing.

A good arrangement set up could be easily made for final photography of filmstrip from sequenced correct size photo enlargements using sheet metal plate marks coated dull black. Near focussing attachments are available in many cameras like Leica, Canon etc. At present only one make—National 35mm camera is made in India. 35mm films are available (slow and fast).

For printing release positive 35mm film is used. A printing frame could be easily improvised. Correct exposure could be determined by trial. About 1 count with the frame held at a distance of 1½ metres from a 60 W frosted lamp would be sufficient.

Development could be done using red safe light. The image should appear within about 1½ minutes when the picture appears on the back. The film is transferred immediately to a combined fixing hardening both (200 grams of hypo, 25 grams of chrome alum in 1000 ml of water). Fixing is rapid and the film when completely transparent is fixed.

Washing thoroughly to remove traces of hypo is important. The film after washing is dried.

The Overhead Projector

The name comes from the fact that the projected image is behind and over the head of the speaker. In overhead projection, a transparent visual is placed on a horizontal stage on top of light source. The light passes through this transparency and then is reflected at an angle on to the screen in back of the speaker. Using OHP is not a new concept. It dates back to World War II when the armed services employed this equipment for teaching recruits.

The Design of OHP

Overhead projectors are designed for direct or indirect projection. The projectors designed for direct projection use either Halogen lamps, linear or pea (650 W) or in some cases 30 volt locomotive head lamp, worked with a transformer.

The overhead projectors designed on principle of indirect projection use the tubular projection lamps (750 or 1000 W) as in a film projector.

In all the overhead projectors, the lamp enclosure is blower cooled. In some overhead projectors, the blower is kept working till the enclosure cools to normal outside temperature by using thermostat (bimetallic) switches which switch off the blower. In such projectors, only the lamp should be switched off and the power supply should be on to enable the blower working.

A fresnel lens is used to form a converging beam of light which illuminates the stage area uniformly and converges to the projection lens. The projection lens is a combination of two lenses with their principal axis at right angles. A surface silver or surface aluminised mirror or a very thin flat mirror serves to rotate the path of light by 90. The lens head could be rotated to form the image at any height. In some projectors, the mirror is rotated to do the same function. The screen usually of 1 cm thick jolly board or plywood (.5cm) or hardboard (3mm) is painted with non-glossy white paint and fixed to the right side corner near ceiling at an angle of 30-45 degrees to the vertical. This tilting is necessary to prevent keystoning. The OHP should be kept necessarily in a fixed place so that the rotated projection axis meets the screen normally and the teacher does not cast a shadow on the screen.

The general precautions to be observed for use of any projector should be observed when using the OHP projector. The projector should not be subjected to mechanical vibrations. Provision for voltage fluctuation should be taken care of by using a voltage stabiliser or by having a suitable choke in series. Halogen lamps particularly will not withstand heavy surge in voltage. The lamp should not be touched by hand. OHP should not be kept on continuously for long periods. To use it as one would use a chalkboard is a very costly procedure. The fresnel lens is protected by a glass plate on top. It is necessary to remove dust or dirt on the protecting glass and also from the outside lens surfaces by flat camel hair brush. Surface silvered or aluminised reflector should not be cleaned.

Advantages of OHP

1. *Large image :* A very large projected image in a minimum of projection distance is obtainable.
2. *Face the audience :* The teacher can always face the class, maintaining eye contact with the pupils. There is no "back and forth" action when using the OHP as in the case of chalkboard.
3. *Lighted room :* This equipment can be used in a well-lighted room which enables the teacher to develop a sort of 'circuit of understanding' by watching the expression of others.
4. *Identity with the user :* Whether in a teaching or a presentation situation, the audience sees the visualisation from the same point of view as the communicator. The feeling of oneness with the communicator is created.
5. *Light weight* : The comparative lighter weight of the equipment makes it portable.
6. *Flexibility and versatility* : The "user operated" visualisation may be integrated into the total presentation with complete flexibility. The teacher maintains complete class control and interest in a lesson by turning a switch on or off.
7. *Personalised presentation :* A personal approach is possible because projection materials may be tailor-made by the person who will use them. By employing some of the techniques like pointing method, revelation technique, silhouette technique and presentation of visuals step by step with the help of overlays, the teacher can enhance the interest in the lesson and maintain attention.
8. *Home-made materials :* Effective visuals can be made in a minimum of time and at low cost. Once a transparency is made, it is permanent. It need not be erased as in a chalkboard.

Method of using OHP

A triacetate film of minimum thickness is available as a continuous roll. This roll could be constantly rolled over the illuminated stage. Matter clearly written or continuously created over the surface could be presented on the screen. This method of using the OHP requires the projector to be continuously working during the entire period. This procedure is costly as the lamp has a limited life and the projector may also get very hot in spite of cooling arrangement. Matter can be permanently written on acetate sheets using quill or ruling pen or rapidomat pen with special Indian ink or acrylic markers with special inks. Temporary, erasable impressions may be created with Chinagraph pencils, also called glass marking pencils (wax pencils), and water colour markers with special inks. These impressions can be removed by wiping with a dry cloth or cotton waste. Acetate sheets may be cleaned with sponge dipped in detergent or soap solution.

Tri-acetate sheets are also available in large rolls of 75 cms width which could be cut into sheets of dimensions 20×25 or 25×25 cms. They can be suitably mounted on suitable cardboard mounts. Poster boards make attractive mounts.

Method of Preparing Transparencies

1. *Hand-drawn Transparencies*

The required visual is drawn to size, confined within 25 cm square, leaving a margin of 2—3 cm on white paper. The acetate sheet is placed over the paper and kept in position by paper clips or pins or self-adhesive tape. The sketch is carefully traced using ruling pen, or rapidomat pen or funnel pen with good quality Indian ink.

Some felt marker or acrylic tip markers write directly on acetate. e.g., colo chisel marker. Water colour markers and brush pens also could be used. But water colour impressions could be easily erased. Hence if the transparency is required for permanent use, the impression carrying surface should be protected by either clear varnish spray or keeping another acetate sheet over it.

Good line drawings and typewritten impressions can be made on acetate sheet using hecto-carbon paper. The procedure is the same as that of using ordinary carbon paper over plain white sheet.

Acetate sheet may be coated with good quality gelatin. About 5 gms of gelatin is dissolved in 25 gms of water by boiling. The solution is applied evenly with a flat brush on acetate sheet. On the coated side, it is easy to draw with good quality Indian ink. The sheet can be coloured using transparent water colour.

2. *Photographic Transparencies*

Employing reflex printing process, negatives on reflex printing paper can be made of complicated diagrams or rare pictures printed on books or composed diagrams using Indian ink. With these negatives, positives can be printed on sensitised dia-positive acetate (Indu-Hindustan Photo Films Manufacturing Co. Ltd.) The acetate film is available as sheets 10″×12″ or rolls. The picture can be coloured using transparent water colours.

The dia-positive acetate sheet also can be used as bromide paper and direct enlargement made on it from any photographic negative using an enlarger. The enlargement can be coloured.

3. *The Diazo Process*

To make a large number of copies of transparencies, diazo chemical coated acetate can be used along with master drawn on translucent paper. The two are kept together exposed to sunlight or ultra-violet source for suitable time (2 to 3 minutes). The image will develop on exposure to ammonia 'vapour. Beautiful coloured overlays can also be prepared by this process.

4. *Copying Machines*

If we are to consider OHP as the heart of the projection system, copying machines are the arteries that feed the heart. These machines produce the positive and negative transparencies from the original material. In the infra-red copying machine, the transparency film is placed in contact with the original. The exposure dial is adjusted to provide desired image density. The original and film is fed into the machine and in just 4 secs. a transparency can be obtained in black and white. O.H.P. transparencies may be made easily and quickly by such thermographic processes.

Specific uses of OHP

The real advantage of the OHP lies in the different uses to which it can be put. Instead of presenting static pictures on the screen, the teacher can develop the diagrams. The teacher by moving an opaque or coloured pointer on the stage, can very easily focus the attention of the class on the screen, on the required aspect. The teacher can cover the completed visual on the stage and by sliding an opaque cardboard can progressively disclose one item at a time in stages.

One of the most effective ways to teach with overhead projector is using *overlays.* This is an effective technique for presentation of material in a step-by-step fashion. The information that is to be presented can be broken down into component parts. A transparency is made of each component and then the component transparencies are taped together. The basic transparency is mounted in a frame and three overlays can be hinged to the side of the frame. The series of components are then flipped into place on the stage of the projector as the information is developed in the class. For example, a geography teacher may wish to show a country depicting its rivers, mineral deposits and major cities. The first overlay transparency would have lines representing rivers; the second would depict only the mineral deposits, and the third overlay would show only the major cities.

Sectional Models : To explain the working of certain machines lift-pump may be made with tinted acrylic sheets cemented by chloroform on clear acrylic sheet, along with pieces which can be moved in slots or rotated about rivets will be highly effective.

Small live aquatic animals may be kept in a flat glass dish and get projected. Leaf profiles, flower petals and details can be projected. Silhouettes of small flat objects may also be projected using sectional models. Even dynamic demonstrations like rotation of a magnetised needle when a magnet is brought near could be shown.

Microprojection

Science teachers want students to make accurate observations and to draw correct conclusions from what they see. Sometimes, live insects and specimens in microscopic slides may have to be viewed by a small group of pupils in a biology class. A microscope can normally be employed for this purpose. While adopting this technique, the teacher can draw the attention of the pupils on any salient feature in the image. But the teacher is not sure whether an individual observes what he says because only one student can observe through a microscope at a time. In such circumstances, microprojection can be resorted to using simple dissecting microscopes or compound microscopes. Microprojection is a technique by which the actual microscopic slides or tiny objects can be enlarged and the image of which can be projected on a screen so that a small group can view it. Rear projection will result in a brighter image. Since power of magnification is very high, the illumination used should be very powerful and this may be secured by making the room totally dark.

Powerful illumination will result in heating of the specimen or causing damage to slide. Live organisms can be kept in a liquid medium which will reduce the heat. When dissecting microscope is used, live objects like mosquito larvae, tadpoles etc., can be kept on a watch glass. In the case of insects, it is difficult to keep them in the brightly lit hot area, as the specimen will move to cooler sides. The illumination can be switched off periodically. When a compound microscope is used, a few drops of water may be placed on a microscope slide and micro organisms like paramecium could be projected.

Rear projection screens 20×25 cms dimension will be suitable for micro projection. It will be necessary to cut out stray light by suitable shields.

Light from a filmstrip/slide projector suitably condensed using additional lenses will serve as a bright light source.

Profile Projector

In profile projector, direct projection is used. Rear projection screen is used to form the image. The projection lens is of very short focal length so that with a short throw comparatively high magnification results.

Profile projectors are used to make a study of very small machine parts like parts of a watch, gear wheels, etc. Large rear projection screens fitted to compact cabinets could be made. The beam of light rays emerging from the projector is reflected 3, 5 or 7 times from good quality mirrors before reaching the rear projection screen. It is equivalent to having a large throw. Only profiles or silhouettes of objects will be seen.

Holography

Holography is described as the "most exciting advance in imagery, since the advent of photography itself". The word "holography" comes from the Greek words for "whole" and "to write" and refers to the production of a three-dimensional image of wonderful reality. Such pictures are called *holograms*. Holography is also sometimes called "lenseless photography" because images are created on a holographic plate without a camera, but by using a 'laser' light beam split into two parts, one of which is reflected off the subject on to a photographic plate and the other known as a reference beam, is reflected off a mirror and on to the same photographic plate. Today, holography is coming to be used in moving pictures also and among its practical uses, we have, *instructional holograms* of use in classes. However, in spite of its enormous future potential, its implications for schools are less clear and certain at the present time.

Microfilm and Microfiche

Microfilm and microfiche are now in wide use on the area of information storage and retrieval. Microfilms contain photographed reading material on 35mm film, with each frame accommodating a greatly reduced separate page. The rolls of microfilms are placed in microfilm readers which project each page on a rear vision screen.

Now with the advance in the technology of miniaturisation, microfiche is used. This is a sheet of film carrying many rows of images of printed matter, much more greatly reduced in size than on a microfilm. For example, a 4″×6″ transparent microfiche card can carry 3360 pages of printed pages on it. These can easily be stored and retrieved, and projected for reading. The educational potentialities of these innovations are really staggering.

Motion Picture Projector

Motion picture as an aid to teaching is inferior to direct experience. In some cases motion picture will be able to provide the expected learning outcome better than even direct experience. The bright image on the screen with the associated sound is more realistic if it is in colour. It provides a vivid, dynamic visual which is remembered longer than any other visual presentation.

Motion picture films can be classified as entertainment films and educational films. Educational films may be further subdivided into general educational films, and class-room films. Classroom films are on curricular subjects produced for promoting learning in a specific curricular subject. Educational films are produced to provide general knowledge. Educational films should be films devoid of anti-social activities, and abnormal behaviour. Some entertainment films can be classified as educational also. Any film can be considered educational if it promotes learning in general in any aspect of knowledge, correct attitude and behaviour.

Advantages of Using Motion Pictures in Teaching

The following are the advantages of motion pictures in teaching :

1. Motion presents certain meanings involving motion. Action gives impression of reality and promotes better understanding.
2. Motion pictures compel attention and, as a result, help in permanent retention of observed events.
3. Many general topics can be covered and conveniently presented in an easily digestible form and in an interesting way to maintain attention.
4. Fast and slow motion can be shown to occur at normal speed, making analysis and appreciation possible. Slow motion technique is slowing down the action as in the case of a fast working machinery and movement of the limbs and parts of body in sports events and games. Sometimes the slow movement is shown to take place rapidly in the screen

by employing fast motion technique. Events like crystal growing, plant growth, flower blossoming, etc., which occur over days can be made to appear to occur in seconds. This technique used to produce such films is called 'time lapse photography'.

5. Motion pictures present materials that cannot be seen by the human eye and even by the microscope and telescope. Technical *animation* involving animated drawings can effectively serve to explain things that are too abstract, too large, too hidden or too theoretical for effective comprehension as well as working of machines, processes and movement of atoms, molecules etc. There is also *iconographic technique* in which we do not need hundreds of pictures as in animation. In this technique, the camera moves over a picture, concentrating on different parts at different times usually highlighting these by varying lighting and perspective.
6. Motion pictures bring the past and the distant to the classroom.
7. Motion pictures reach a mass audience at a low average cost per person.

General Classification of Motion Picture Films

Educational films can deal with

(a) Films about achievement due to advancement of knowledge in technology.
(b) Popular science films
(c) Travel films bringing the world to the classroom
(d) Sports films
(e) News and information films
(f) Health education films
(g) Films aimed to produce and encourage social awareness and expected behaviour of individuals towards betterment of society
(h) Films about working of industry
(i) Films about working of big institutions, hospitals, etc
(j) Nature films dealing with flora and fauna
(k) Historical events.

Films of this nature are produced by the Films Division, Bombay in several languages. These films are available free of hire charges to educational institutions. In addition, classroom films or films on all curricular subjects are available from the Film Library, Department of Teaching Aids, Ring Road, New Delhi to educational institutions. Many foreign embassies like U.S.S.R., German Democratic Republic, National Film Board of Canada, British Council, French Embassy, Netherlands Embassy have very good films which can be shown to advantage in institutions.

Principle of Motion Picture

The motion film capitalises on the weakness in the human eye which is called the persistence of vision. Any object that is seen by the human eye will remain in the field of vision for a small length of time, i.e., 1/16 second even though the object recedes. Hence if a series of 16 still pictures are taken in rapid succession, developed and finally projected on the screen as a series of pictures, it will give the viewer a sense of motion. The addition of a sound signal results in a sound motion picture. Normally 24 pictures per second is the norm adopted for sound films and 16 pictures per second is the standard adopted in the case of silent films. A revolving shutter excludes the light during the time required for one frame to move out of the light beam and the next frame to move into it.

Technical Animation

Animated cartoon treatment is often used in films to simplify and clarify concepts. Generally, unobservable action may be skilfully portrayed diagrammatically. This technique allows improbable situations and unfamiliar relationships to be portrayed clearly on film. This technique constitutes a valuable contribution of the film medium to teaching. *X-ray+motion photography* helps one to understand proceses as they occur within the ordinarily invisible interiors of plants, animals and men.

Films of Different Gauges

Motion pictures are made with cellulose acetate which is not highly inflammable and hence are called safety base films. Highly inflammable nitrate base films are not manufactured now. The following is the description of the films made in different widths.

1. 35mm Films : These are available in black and white or colour and have perforations on either side. These are used for production of commercial entertainment films and filmstrips. If used for filmstrips, there will be 16 frames 'per foot in single frame filmstrip and 8 frames per foot in double frame strip.

2. 16mm Films : 16mm films are used for production of educational films, in black and white or colour. There are about 40 separate frames or individual pictures in every foot of 16mm motion picture film. The running time of a 400-ft reel of 16mm film is approximately 11 minutes. The sound film moves at the rate of 24 frames per second while the silent film moves at the rate of 16 frames per second. Hence the running time for a 400-ft silent reel is more than 15 minutes. Further sound films have perforations only on one side of the film and on the other side there is the sound track. The sound track can be recorded using variable density of variable area optical techniques. 16mm films can also be provided with magnetic tape striping on one side for magnetic sound recording. Silent picture films have perforations on both sides.

3. 8mm Standard Films : This kind of film with single side perforations is now getting obsolete. There are 80 frames per foot in this type of film.

4. 8mm Super Film : This film either in black and white or colour with single side perforations is now extensively used in loop cassette projector. 8mm super film could be provided with magnetic sound track only. 8mm super film is gradually replacing the 16mm gauge film for use in educational institutions to impart instruction. There are 72 frames per foot in this type of film.

5. 70mm Films : 70mm film with provision for magnetic recording in multiple sound track is used to make high class commercial entertainment movies. Rear projection or using curved aluminium screens makes it possible to show an adequately bright picture even when there is some extraneous light.

Motion Picture Projector

There are many different 16mm motion picture projectors, made by various manufacturers. Each has its distinctive characteristics and advantages but all are similar in principle.

The principle involved in a motion picture projector is this : An object kept in between *f* and *2f* of a convex lens will produce a real enlarged image beyond *2f* of the lens on a screen. In the case of motion picture projector, the object is the transparent film. The film unwinds from the feed roll and goes through the picture head where it is illuminated by the light-source and is then projected on the screen kept at a distance by the projection lens. Then the film passes through the sound head to give sound. Here the sound track on the film is illuminated by the exciter lamp and its image is turned into corresponding electric signals by a photo-electric cell assembly. These signals are then amplified by means of an amplifier and fed to the loudspeaker assembly. The film is finally rewound on the take up spool.

Operation of Motion Picture Projector

Threading : The feed and take up spool arms are fitted in proper position. The drive belts are fitted. The film is threaded into the projector according to the diagram given in the projector itself.

Threading is done using 5′ leader in film. The film runs through as follows : from feed spool - sprocket - upper loop - film gate - lower loop - pressure roller - sound drum - sprocket 2 - guide roller - take up spool. The perforations in film should be properly engaged by sprocket teeth. Upper and lower loops are necessary since film runs at constant speed at sprockets but in jerks at gate. The film should go tight over sound drum as otherwise sound reproduced will be distorted.

Starting and Running : The following is the operating sequence :

(a) check threading of film,
(b) switch on amplifier,
(c) switch on projector motor,
(d) make sure the blower is operating. A blast of cool air would be felt over the lamp house,
(e) switch on lamp,
(f) focus the picture,
(g) frame the picture, if necessary,
(h) increase the sound volume to required level,
(i) adjust sound quality by operating tone control,
(j) while the film is running it is necessary to gently feel the perforations as the film enters the take up spool. This is done to find out if the film is properly spooled without damage,
(k) when end is projected on screen:
    (1) switch off lamp,
    (2) when the entire film is in take up spool (film reel have 3′ trailer) switch off motor,
    (3) decrease sound volume to zero,
    (4) switch off amplifier,
    (5) Rewind switch is put in rewind position and film is rewound and spooled. Projector is left for some time to cool and then only packed.

Rewinding can be done using a hand rewinder. While using the hand rewinder the film can be checked. Any spoiled portion can be cut off and remaining spliced. Films are spliced using film splicer and film cement. Using splicer ensures that the distance between perforations is not altered at joint. Film cement bottles should not be kept open. The volatile solvent will evaporate and cement will become useless.

Films should always be kept in containers in rewound condition so that they are ready for use.

The following spares should always be kept in stock :

(1) Take up spools—400′, 800′, 1200′ and 1600′,
(2) Spare spring belts,
(3) Exciter lamps,
(4) Projector lamps,
(5) Cartridge fuses,
(6) Oil for lubrication,
(7) Film cement,
(8) Lens cleaning liquid—cleaning cloth,
(9) Camel hair brush for cleaning gate,
(10) Film rewinder and splicer.

Sound Reproduction

Sound recorded in the sound track is converted into sound using photo-electric cell. Light from an exciter lamp is incident on the moving sound track. The light is restricted to a very thin rectangle by a slit. The light transmitted by sound track is incident on a photo-electric cell. Since sound track transmits different intensities of light, as it moves along, the light incident on the photo-electric cell is varying accordingly. This results in a similar varying current through the photo-electric cell and the resistance in series with it. The potential across the resistance is amplified by using an amplifier. The output from the amplifier is connected to the loudspeaker which reproduces the sound. Projectors now made have a photo diode and use a solid state amplifier. If no sound is emitted during projection it may be due to the following factors :

(a) amplifier not switched on,
(b) fused exciter lamp,
(c) exciter lamp not energised,
(d) loudspeaker connections not made,
(e) volume control at zero position.

Motion Pictures as Aid to Teaching

An instructional film should be shown at the proper time only. For example a film of 'electromagnetic induction' should be shown only when that particular topic is taught. There should be adequate preparation and follow-up work along with the screening of the film, as these induce pupil involvement practically doubling the learning outcomes. The following flow pattern will result in maximum benefit.

1. *A felt need* : It is felt that a film on electromagnetic induction

will help considerably to promote full comprehension and understanding in pupils. The film could be used to supplement other media. Perhaps a film on the life of Michael Faraday if shown would inspire the pupils and hence would be appreciated at this time.

2. *Selection of suitable film :* The teacher gets a number of films on the topic and, if possible, preview them to find out the suitability for his needs. He should consider the age group, entering behaviour of the pupils while selecting the proper film. He should find out if the commentary could be understood by the pupils. He decides upon the nature of preparation needed. He also creates good viewing conditions, paying attention to ventilation, seating, arrangement of projector, screen, speaker etc.

3. *Preparing the pupils*: Relevant supplementary aids are brought in to motivate the pupils. For example, a dynamo with provision for rotating the armature manually connected to a lamp, a cycle with a dynamo and lamp fitted may be brought to the class. Though these are common objects the pupils evince lot of interest when the lamp glows as a result of the rotation of the armature. Pupils would like to know the 'why' of it and also some details about the inventor.

4. *Reinforcement* : The film on electromagetic induction is projected on. If the commentary provided is unsuitable or inadequate for the class, the teacher can provide the necessary commentary. After the screening is over, the teacher gets a feedback by posing questions. Wrong concepts are clarified. The film may be followed by a demonstration experiment to show induced e.m.f. when there is relative motion between conductor and magnetic field. All experiments shown on the film are repeated. The pupils get confirmation of what they have seen on the film. There is complete and clear understanding. The students would have also seen application in daily life of the phenomenon of electromagnetic induction.

5. *Rescreening* : The film is shown again. Often students will learn more if they can see the film again either immediately after discussing it or at the start of the next class period.

6. *Follow-up* : Consolidation and practical application of knowledge gained could be by giving assignments, problems involving writing answers on paper or collection of data or further reading or doing practical work. Pupils can also be asked to work on related projects or any related creative activity. It would also be better if the teacher *evaluates* the film for later use, using a standardised film evaluation record.

Motion films selected for the specific purpose may be shown to pupils before they launch on field trips. Motion pictures may be shown before a group of pupils embark upon a project. There are quite a lot of motion pictures dealing with problems connected with teacher training and education of retarded and gifted children. Films are only resources ; they are seldom complete teaching units in themselves. Their value is like that of all other instructional media; it will depend on how well a teacher uses them in classrooms.

Many research studies have been undertaken on the impact of silent and sound films on the behavioural development of pupils. The results reveal that such films used properly accelerate cognitive learning of pupils and retention is also comparatively enhanced. There is also strong evidence to support the view that motion pictures exert a measurable positive influence on the feelings and attitudes of pupils. Research findings point out that appropriate films used wisely bring about increased student interest in instruction resulting in greater interest in reading.

Loop Cassette Film Projector : (Standard 8 or Super 8)

Loop films are run only for a short duration, i.e., for a maximum of 5 minutes. No special procedure for threading is necessary to run the film. The cassette is merely inserted in the slot provided and then pressed in position. Separate projectors should be used for standard 8, super 8 and new super 8 films. Magnetic sound track cassettes are also now made differently. Usually loop cassette film projectors are used with rear projection screens. If they are used with front projection screens, size of the formal image could be adjusted to a certain extent since zoom lenses are provided for projection.

When the film is projected from beginning to the end, again it starts and continues. Any frame may be stopped for closer scrutiny. The film is joined end to end and hence could run continuously and repeated again and again.

The content of the film is on a single theme only and the film is expected to be viewed by the individual pupil in the library. Repetitive actions help the children in permanent retention. The pupil watches the film so many times that the idea or concept gets impressed in the mind.

Loop films particularly are useful to pupils to develop specific skills. A technician trainee watches gear cutting a number of times. He becomes an adept in it and gains sufficient knowledge to practise the process in reality and produce results.

Film loops are very cheap in comparison with the long films because they repeat the same actions. Examples of film loops that are of particular interest to science teachers are those showing the working of four-stroke internal combustion engines, valves and pumps, the solar system, the action of heart etc. Knitting, sewing, home science, teaching correct procedure in specific aspects of games and sports are some of the areas where loop cassette film production shows promise.

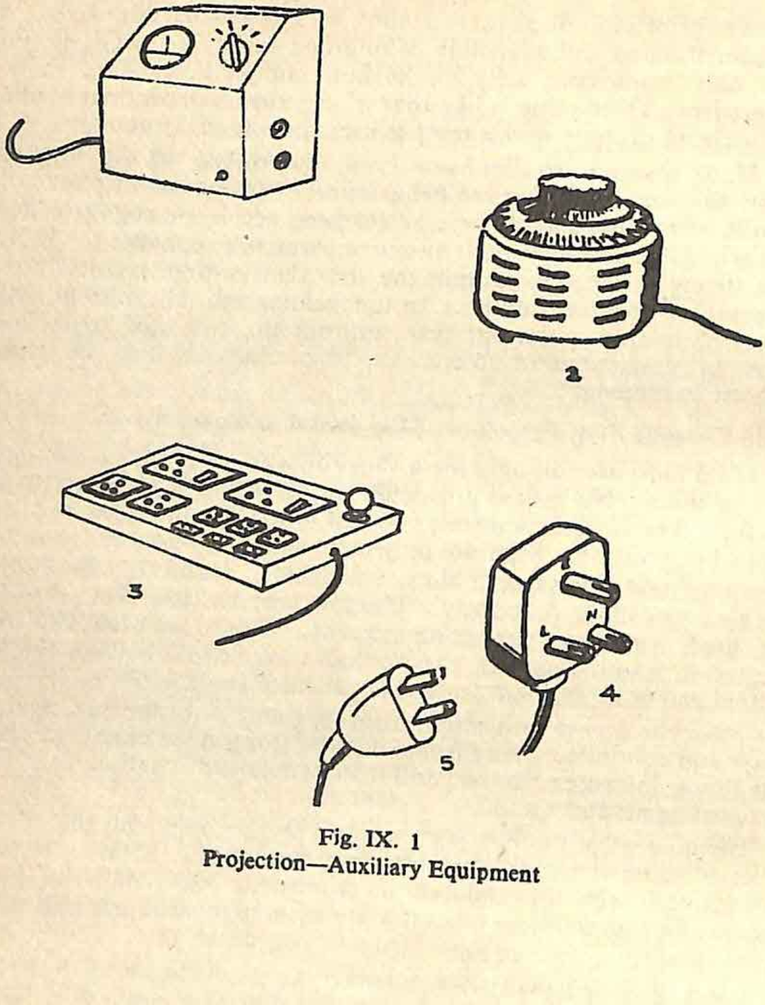


Fig. IX. 1
Projection—Auxiliary Equipment

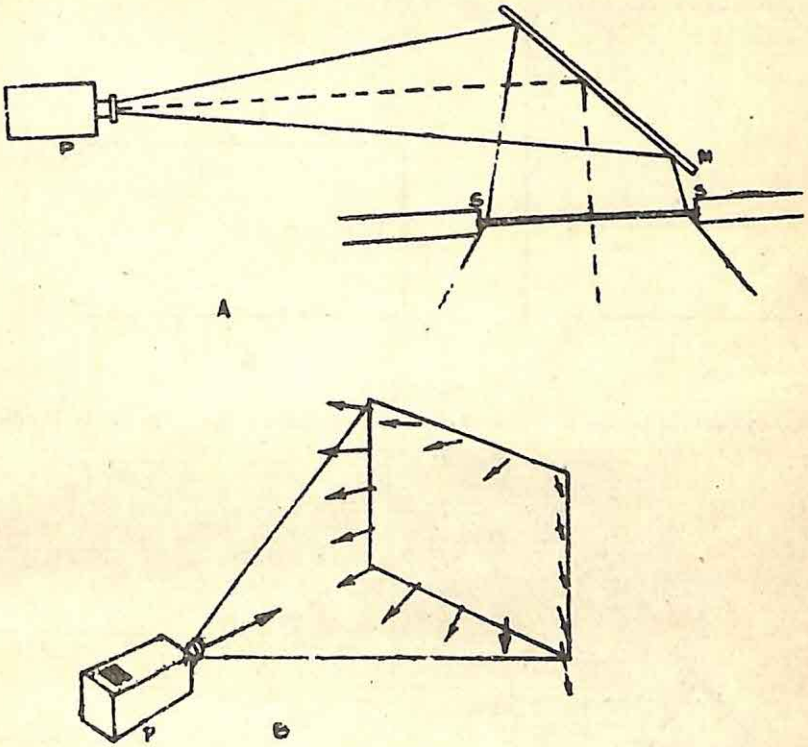
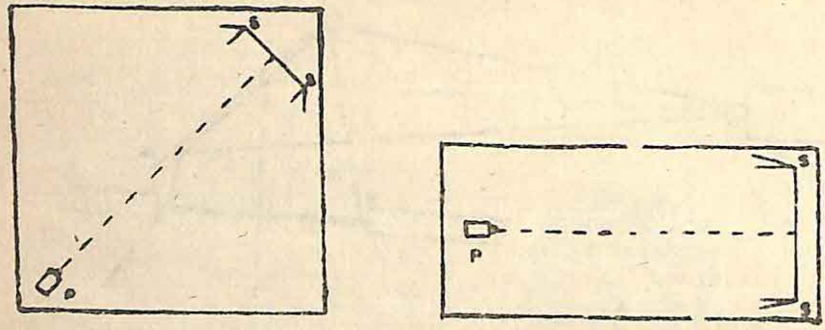


Fig. IX. 2
A—Rear and B—Front Projection



A B

Fig. IX. 3
Front Projection Screen A—Square Hall—Matte Screen B—Long Hall—Beaded Screen.

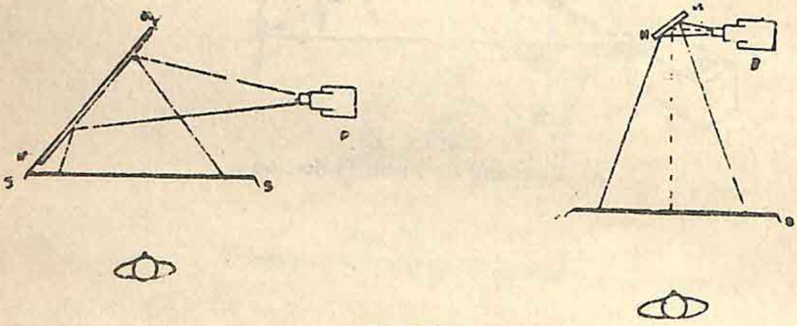


Fig. IX. 4
Rear Projection Screen M.M—Plane Mirror-45° to Projection Axis.
S.S. Translnseent Screen.

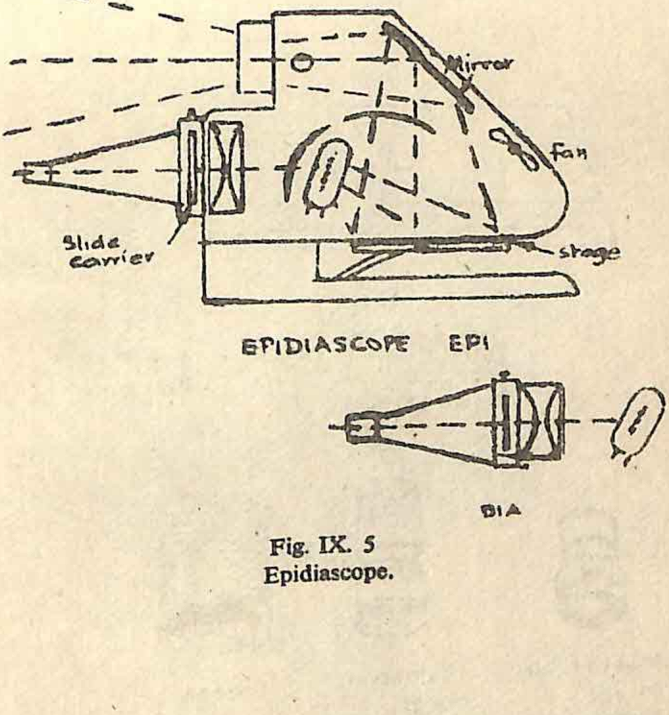


Fig. IX. 5
Epidiascope.

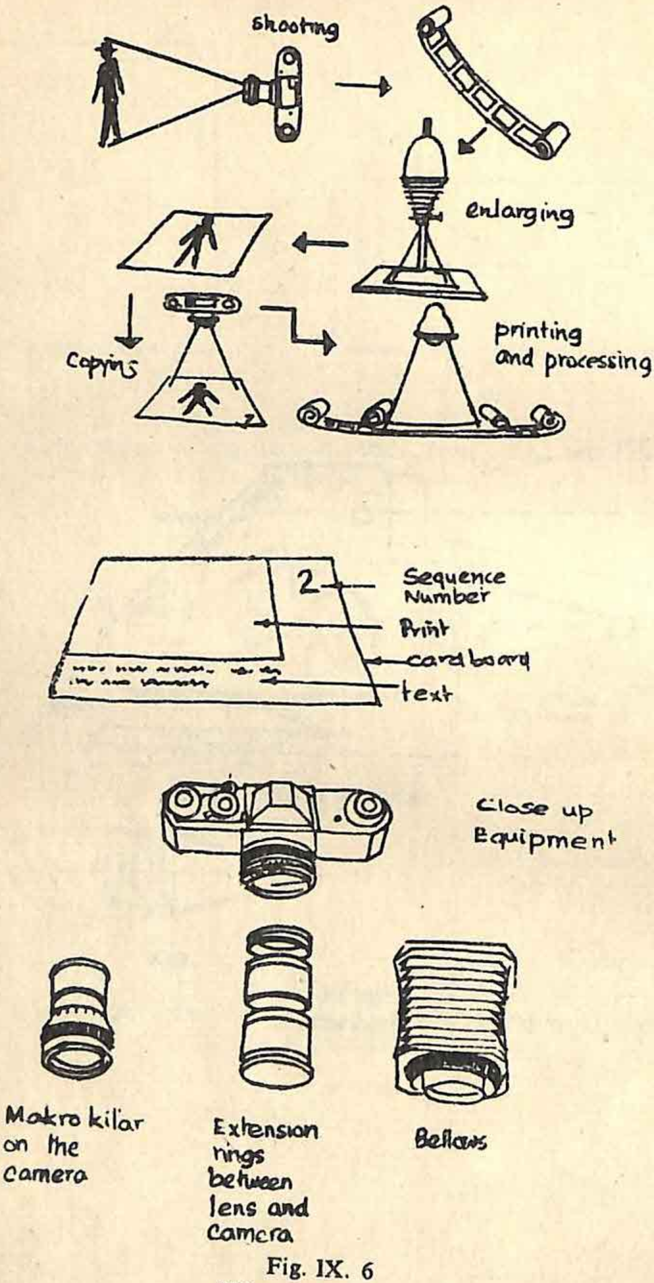


Fig. IX. 6
Filmstrip Production

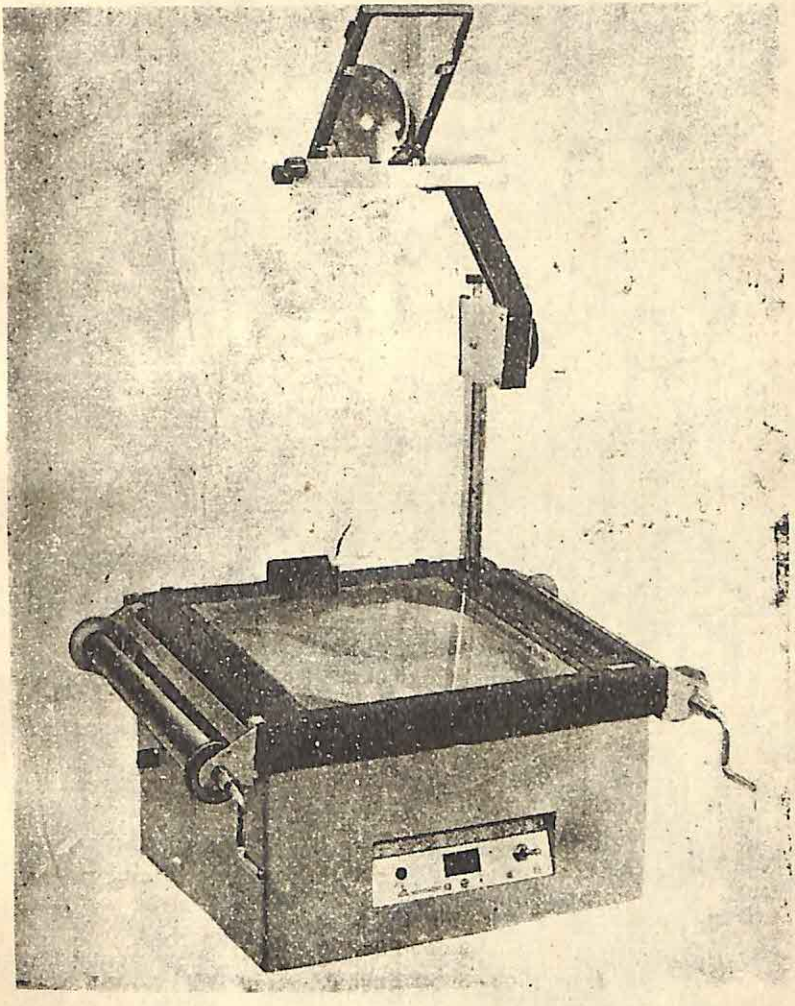


Fig. IX. 7
Overhead Projector

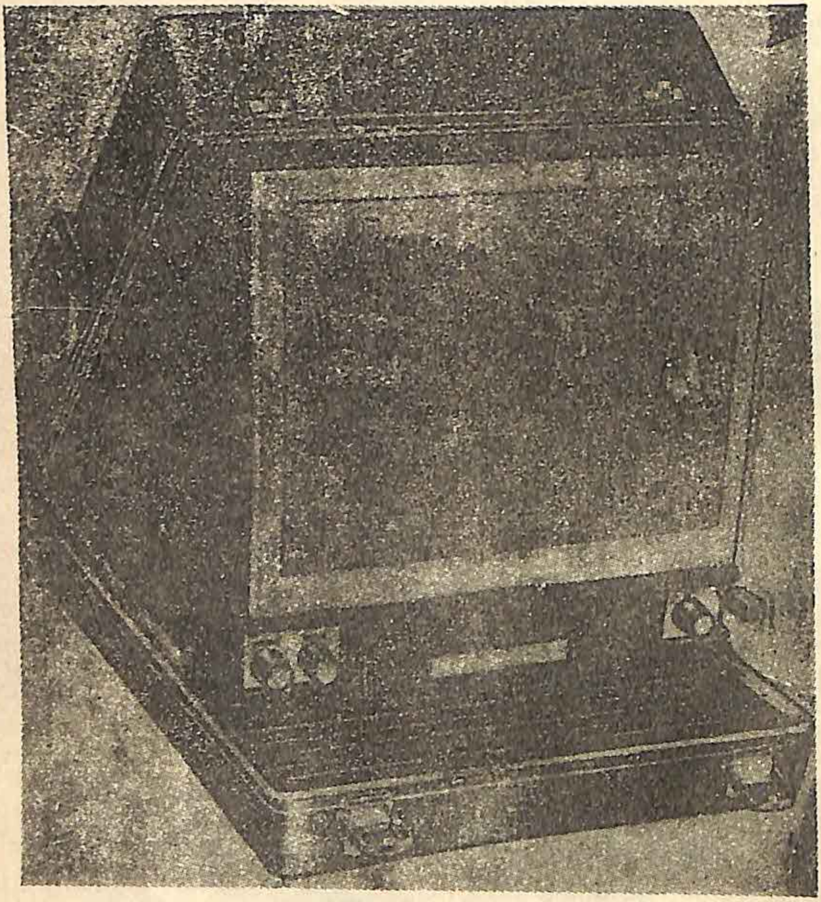


Fig. IX. 8
Loop Film
Instavision—Super 8 mm Projector

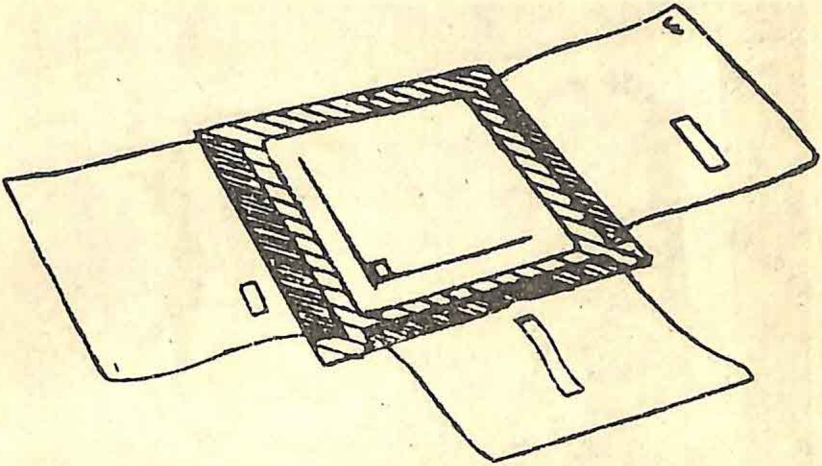


Fig. IX. 9
Overlap for OHP

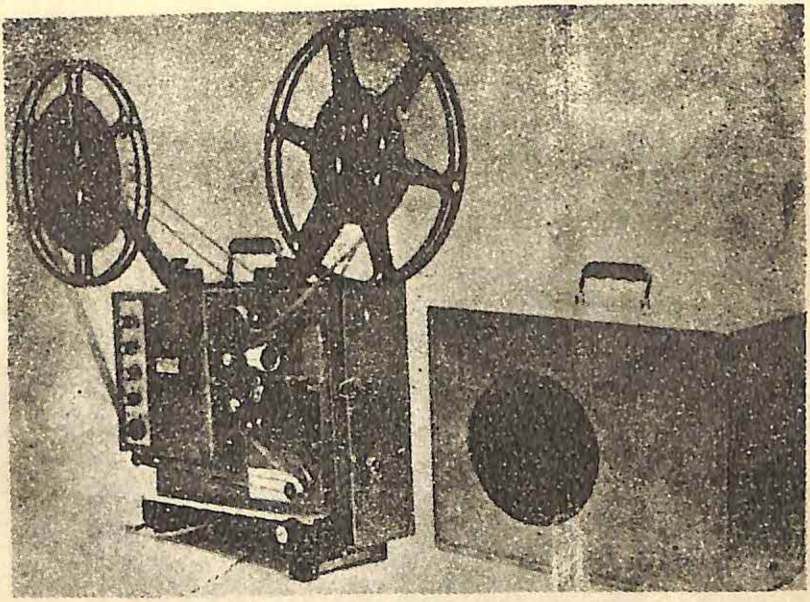


Fig. IX. 10
16 mm Sound Film Projector

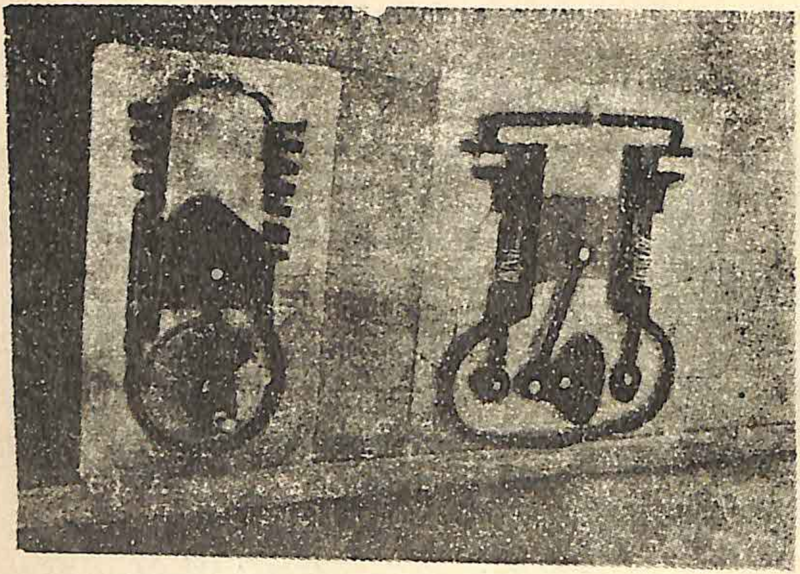


Fig. IX. 11
OHP Transparencies
Acrylic Sheets

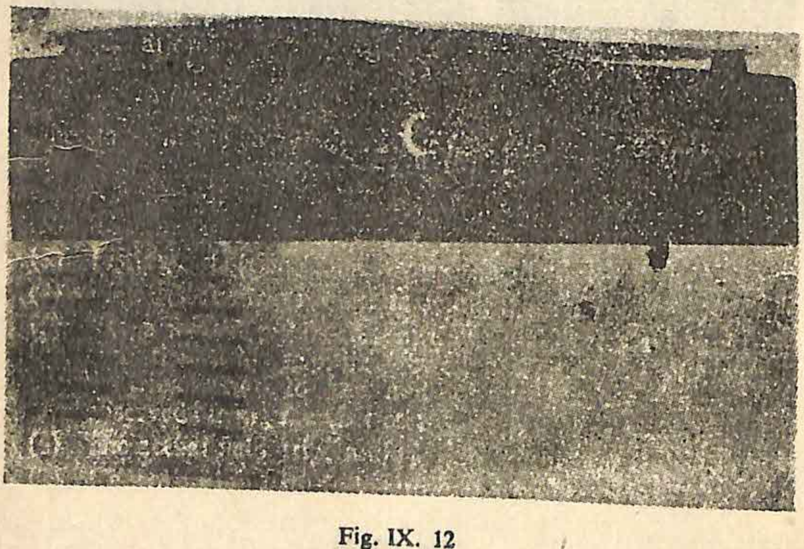


Fig. IX. 12
Voltage Stabilizer

CHAPTER X

DIRECT EXPERIENCES

Field Trips and Excursions

When one refers to a dictionary to find the meaning of the word "excursion" he will find the following: "journey, ramble with intention of returning, pleasure trip of a number of persons", etc. The term excursion is usually used when a person or group of persons undertake tour of places where they expect change from normal daily life. Such excursions are undertaken mostly for recreation and pleasure.

When excursions are undertaken by students of an educational institution the main aim is not only recreation and pleasure but also gaining additional knowledge through direct experience. Hence it is necessary to select a suitable place to visit. When excursions are undertaken for the specific purpose of development of knowledge of pupils, the same can be justly called in a general way as "study-tour" though the term study-tour is used when an individual makes a tour for study purposes. But a group of pupils consists of individuals. In such a case, the activity is styled as "field trip".

The specific advantage of a field trip lies in the fact that after the completion of the same the pupil can justly say "I have seen" instead of "I have read about" or "I have been told" etc. During the field trip the pupil has concrete learning experiences in a real situation which has been undertaken with a specific purpose.

Types of Field Trips

(a) *Local School Trips:* These are arranged to various parts and sections of one's own school building and grounds to see procedures, equipment and materials, e.g., measuring distances, studying trees, shrubs and flowers, practising health and safety procedures, etc. They are done during regular scheduled periods.

(b) *Community Trips :* It is the usual trip to some nearby place like a zoo or a museum. It takes longer than the regular class period.

(c) *Tour or Journey:* They may last for several days. These trips are also popular at school level. Children are transported in school or specially chartered buses. Proper planning and organisation for execution are essential.

(d) *Imaginary Tours:* Details of the real tours are investigated, studied and planned, materials are collected, decisions are taken on trip destinations regarding their routes, cost, etc., but the destinations are seen by means of motion pictures, slides, photographs, objects, reports and recordings, etc.

(e) *Inter-school visits:* They may be of the following types:

  (i) A specialised group like music or science club visits the corresponding organisation of the other school for exchange of ideas relating to mutual interest.

  (ii) A group or a class or even all sections of that class visit another school for half a day or a day.

(f) *Individual Trips:* Here a pupil or a group of pupils may take this because of an assignment or some responsibility in connection with some curricular or specialised interest. This kind of trip is very popular for collecting biological specimens and fossils for the study of natural sciences and anthropology. The student learns to recognise and discharge responsibility which are such important elements in education.

Organising a Field Trip

The stages in the completion of a field trip are:

(1) A felt need;
(2) Selecting a suitable place;
(3) Listing out specific objectives of field trip;
(4) Planning the trip in minute detail;
(5) Preparing the pupils so that they would get maximum benefit from the field trip, i.e., briefing them about all aspects of the trips what to see and observe, safety measures to be observed during the visit etc;
(6) The actual field trip; and
(7) Consolidation with followup activities.

A field trip not planned well in advance will end in confusion and will be a waste of time and money. The field trip should be planned as a cooperative activity involving full pupil participation under the teacher's supervision.

Planning and Conducting: It is necessary to prepare the group of pupils before an excursion is undertaken. The staff member or members who are to accompany the pupils should have visited the place previously and should be fully conversant with the activities in the place. Suitable conveyance, boarding and accommodation at the excursion site should be arranged well in advance. Every minor detail should be thought out and planned.

The pupils should be given a complete idea of the place. Suitable briefing about the field trip should be given depending upon the objectives of the field trip. If necessary any additional technical knowledge necessary to understand any specific process or activity in the place should be imparted. Suitable reading material about the place should be placed at the disposal of the pupils. If any motion picture film depicting the activity in the place is available, the same should be screened several times, if necessary. The pupils should be told what to see and should be instructed to take notes during the visit.

It is essential that the students during visit to the selected place recognise machines, processes, etc., about which they have been briefed. Recognition leads to close observation and better understanding. They should not be surprised and perplexed on seeing things and events about which the pupils have not been briefed. The pupils should be specifically instructed that they should not try to switch on or start or stop any machine and if they are interested in any specific activity the people on location should be requested to explain.

It is essential that the pupils move as a unified group obeying the leader. It may be necessary in certain cases to break into several groups. The visiting group should not act as a source of disturbance to the normal activity at the location.

The students should also be told of possible accidents that may occur and all precautions should be taken to avoid the occurrence of any accident.

In a study-tour aimed to gain knowledge, it is essential that the same is not hurried. Sufficient time should be spent if real gain of knowledge is desired. The party should abide by the rules and regulations of the visiting place. Photographs should be taken only if permissible.

Followup Activity: Every student should write an account of the excursion and get the same scrutinised by the staff member. When the party returns from the tour,seminars, group discussions, quiz programmes, etc., can be conducted during which the knowledge gained can be consolidated. Construction projects should be launched whenever possible. The knowledge gained can be presented in a lucid way, well illustrated by flow diagrams, diagrams and sketches and photographs in the institution magazine.

After participation as a member of a group which had undertaken an excursion to a suitable place, there will be considerable gain of accurate knowledge of things and specific processes since knowledge is gained by direct experience in a meaningful, natural learning situation which is part of necessary activity.

Study of the Community

The most effective way to help students be informed about their social and natural environment is to provide them learning experiences which are real or life-like and which are available to them for first hand scrutiny, questioning and understanding. This view has been emphasised by such great educators like Comenius, Pestallozi, Herbart and Froebel. Today the idea of expanding the experiential resources of a school to include community study or community resources learning is widely accepted.

Aims and Purposes of Community Study

Understanding social life, developing citizenship and civic responsibility, achieving vocational understanding, economic self-sufficiency and most important of all, self-realisation by the pupil are the major aims of community study. But rigid bell time regulations of most schools and narrow compartmentalized course offerings and adherence to the traditional arrangement cause almost all experiences to go on within the four walls of the classroom.

To explore for one's self is the most natural quality of inquiry. The child learns what is relevant to him. Till he comes to the school at about 5 plus he has been spending much of his time in exploring; but when he joins the school he finds himself confined to the classroom for 5 hours a day, 6 days a week and thus runs counter to his mental, emotional and physical make-up. This is equally true in the case of older children who have need to explore and to be physically and mentally active and to express themselves fully through the social channels open to them. Yet the school has often thwarted such needs. Such an approach to education is anachromatic. So arrangements should be made for the pupil to continue his natural exploring behaviour in similar but more directed and appropriate community study activities which permit direct observation, participation, experimentation and questioning. The pupil should participate in carefully planned, school controlled community study experiences. The pupil should be permitted to investigate the school, the village or town, the district and the country. The school should include in its activities for young pupils talks and visits in the community helpers namely, the postman, the policeman, the fireman, the baker, poultry raiser and others of the community. Older and more able pupils should be permitted to range farther a field involving extended stays at camps, study tours and visits to nearby governmental and private concerns, manufacturing plants, public works projects. These will not merely serve as worthwhile learning experiences but will also serve to reveal the facts of and opportunities provided by the society they will enter later as participating adult citizens.

Community study refers to the various learning situations through which pupils come into first hand contact with the people, places and things around them. It includes visits, interviews, participation, listening, examining and questioning with reference to the different segments of community life. It covers walking trips, school journeys, excursions, field trips, tours, etc., as well as visits by resource persons which is a valuable means of bringing demonstrations and specialised information into the classroom, particularly when field study is not immediately feasible. Research surveys are also part of community study activity and can be undertaken by special groups of a few individual pupils.

In pupil-teacher planning for learning through community study, the following steps are involved:

(1) Learner's entry behaviour (what is known/what do we want to know? How can we find out?)

(2) The community study experience which includes: (a) Objectives, preliminary preparation; (b) Mechanics of arrangement; (c) Observing and recording; (d) Learner response; and (e) Evaluation.

In planning community studies, the following points should be borne in mind: (i) The headmaster and staff should plan community resource activities which will help to accomplish specific goals. Such activities should not be confined to festivals, holiday excursions and out of class recreational activities. (2) Meticulous planning regarding transport, stay facilities, food etc., should be done. (3) Parental permission, preferably in written form to take pupils out is necessary.

Evaluation: Community study activities should be judged largely by their educational worth. The following are the criteria by which their worth can be assessed:

1. Was the community study learning experience arranged because it is not only related to specific curricular objectives but more important, because it represented one of the most

efficient ways through which to achieve these goals?

2. Was it worth the time and effort?
3. Did pupils and teachers work together in understanding the planning of the community study learning experience?
4. Was the community study situation engaged in only after teachers and pupils were reasonably sure of why and how the experience was to be undertaken?
5. Did the teacher make the necessary preparation for the study as pre-visiting the place to be studied, preparing the statement of goals and purposes of the study and getting the headmaster's approval, arranging for the details of the trip and getting the parents' permission?
6. Were opportunities arranged during the community study situation for observing and recording by pupils through photography, tape recording, available pamphlets, noting down in note books, etc.?
7. On return to the classroom, did teacher/pupils spend enough time in questioning and responding in order to clarify and consolidate valid interpretations of things learned and conceptualized during the community study experiences?
8. Were appropriate opportunities given to pupils to demonstrate the behavioural outcomes of the community study? (descriptions, essays, arrangement of pictures, specimens, objects, diagrams and charts, preparation of models etc.)

Exhibitions

Exhibitions are familiar items in our environment today. When we go round an exhibition, our attention is often focussed on a group of objects and materials that are displayed according to a deliberate plan. The exhibitions that are arranged in schools are usually planned to communicate something valuable to parents, public and students. The values of exhibitions can be listed as follows.

1. Exhibition is one of the effective modes of mass communication and instruction on a large scale.
2. Self activity is fostered on the part of those who take part in the exhibition. Individual tastes, fancies and skills are exhibited. Special talents become known.
3. The outcomes of different activities and processes are very well understood by pupils.
4. There is a pedagogic value implied in the sense that the

pupils would become good at expressing themselves. Expression is not possible without understanding. Art of speech is trained.

5. Team spirit is encouraged as conduct of an exhibition is a cooperative effort.
6. Other values like avocational value, aesthetic value, cultural value, disciplinary value and ethical value are realised in the conduct of an exhibition.
7. Parents and visitors can have an idea of the work turned out by the pupils.

Exhibitions must be an annual affair. All sections of the school must cooperate and contribute something valuable. The idea of holding an exhibition must be promoted even at the beginning of the year. Teachers must guide and lead the pupils in the preparation of possible exhibits. As the exhibits are got ready, the teacher must supervise the work. There must be effective labelling and the arrangement of the items may be made subject-wise. Sometimes very catchy explanations may not be out of place. The explanations for the exhibits must as far as possible be brief. The students must be trained as to what features of the exhibit must be stressed while giving explanations.

Arrangement of Exhibits

Popular type and difficult and easier type of exhibits must be kept inter-mixed. Too many exhibits should not be kept crowded in a room. The exhibits must be kept in a well-lighted place. Dynamic and static exhibits must be kept mixed so that overcrowding can be avoided. It is better to put one single idea in an exhibit. Colourful and moving exhibits will attract the attention of the people.

Sections could be devoted for art work, creative work with plastic material, graphic work like charts, pictures, posters, etc., on meaningful themes. Puppet shows using puppets made by pupils could also be included in the activity. Educational films can also be screened at definite intervals as they would secure the attention of the people. Even if the school does not have an auditorium, dramas and short plays, shadow plays and musical performances, etc., could be organised utilising full pupil participation on temporary out-door stage.

The entire campus should be clean and should present a festive appearance. Potted plants could be placed at suitable points in addition to paper flags and festoons to enhance the beauty of the place.

The entire panorama of products resulting out of work experience by pupils could be exposed for view during exhibition. Student committees could be formed for different activities connected with the running of the exhibition. There must be enough space for the visitors to move and the volunteers to stand and explain. The volunteers should be provided with badges.

Planning the Exhibits: Edgar Dale gives the following points for planning the exhibits so that they may serve their purpose.

1. Put only one, central idea in your exhibit.
2. Place your exhibit where it is certain to be seen.
3. An exhibit is seen, not read.
4. Make your labels short and simple.
5. Labels should be uniform and legible.
6. Motion attracts attention.
7. Be sure your exhibit is well lighted.
8. Colour may add interest and attractiveness.
9. Sound and various mechanisms add attractiveness.

Museums

Museums are wonderful media for public education. They are institutions that collect and preserve original objects and specimens and uses them for research and for educational displays. The displays often consist of replicas, models and dioramas designed to create interest and educate the public. Museums are repositories with an array of materials arranged in a logical order on a variety of subjects and serve as valuable sources of materials for instruction. There are thousands of museums all over the world and most of these concentrate on the areas of art, history, science and anthropology. In addition every school can build its own museum with the help of teachers.

Museums are permanent institutions unlike exhibitions. Hence every exhibit kept in the museum must have lengthy labels giving details about the exhibit. A research scholar or a person who wants to make a deep study of the subject may devote as much time as possible to look at the exhibit. Most museums in foreign countries work closely with the schools. The qualities of the exhibits placed in the exhibition would apply equally well to the exhibits in museums. Museums are not only places to visit by pupils but in many countries serve as sources of instructional materials to schools.

Demonstrations

Demonstration is a technique which is often used by all teachers teaching various subjects. Ideas, skills, attitudes and processes can be demonstrated. The spoken word is supplemented with demonstration using varied aids resulting in auditory and visual learning. Concrete demonstration through aids is reinforced instruction through two channels, eye and the ear. Although all subject teachers make use of this method, it is often resorted to by science teachers. Especially when the apparatus is very costly and hence availability of the same is limited; when the experiment involves the use of sensitive apparatus which would otherwise be spoiled by clumsy handling; when the experiment involves danger and when the students have to adopt proper method to complete a process, this technique of demonstration can be used to advantage.

Suggestions for Organising Effective Demonstrations

1. All the aids must be arranged in the order in which they are to be used. Fumbling for things will destroy the communion between teachers and pupils.
2. Even though the experiment is simple, the experiment must be rehearsed and all the required materials collected in advance.
3. The experiment must be simple and effective. It should not occupy much of the class time.
4. There must be an element of surprise or wonder in the demonstration.
5. Demonstrations which are simple should be chosen in preference to complicated ones to demonstrate the same aspect.
6. Large size apparatus must be used. Experiments must be demonstrated on a raised platform so that all can see. Proper lighting must also be there.
7. Control experiments should be provided to clarify details.
8. Most demonstrations do not involve the students in its operation and hence the teacher should secure their help in setting up the demonstration and making simple measurements. Sometimes students may be asked to give a few demonstrations.
9. Any demonstration made must have some purpose.
10. Clear and suitable background should be provided for the demonstration set up so that the same should be completely seen by all pupils.

Planetariums

The ushering in of the space age with the need for pupils to understand a whole new set of perceptions and concepts has made teachers realise the effectiveness of planetariums as aids of instruction. The great planetariums such as the Hayden Planetarium in New York or the Birla Planetarium at Calcutta may be utilised by teachers and pupils for their teaching-learning experiential purposes. Along with these small planetariums are also used in schools and are quite adequate for developing understanding of basic space concepts. A planetarium consists essentially of a dome usually mounted on the ceiling, which represents the sky overhead and a special projector that displays images of the celestial bodies on the dome, under which the viewers are seated. The projector consists of various individual units for projections of the sun, moon, planets and stars. These units are moved by motors and precision gears to reproduce accurately the motions of heavenly bodies. The heavenly bodies can be shown as they would appear at any point of time, past, present and future and, if necessary, the action can be speeded up. Addition of taped narration and sound adds to the effectiveness. Learners of any age can benefit from viewing the planetarium, which is considered as an effective instructional medium now. Other types of multi-image presentation systems like the cyclorama projection systems involving several slide and film projectors enabling a 360 projection are also now being developed and the educational value assessed.

CHAPTER XI

AURAL AIDS

Educational Broadcasts

Radio broadcast is a powerful media for mass communication. In the present day, broadcasts from a powerful transmitter can be received at very distant places. The range of many transmitters is very large and the area covered is vast. Communication from any part of the world to any other place however remote it is and whereever it is located is possible. Transistor receivers do not require any mains power supply, but could be operated by dry cells. Advancement in electronics particularly in the field of solid state circuits (transistors), integrated circuits, etc., enables clear sound reception from any fairly powerful transmitter without much interference even in remote areas. Medium wave transmitters cater to the nearby surrounding areas and the same programme when broadcast on short waves makes reception at distant places possible.

Frequency Modulation broadcasts recently introduced in Madras will enable quality reception without any background noise.

Classification of Radio Receivers

1. Power source—Mains operated (240V 50 cycles A.C.)
    —Battery operated (dry cells 1.5V or 6 or 9 volt battery)

    This type could be operated with Mains voltage also by using suitable battery eliminator. Further, this receiver could be operated in any location.

2. Receivers (a) with valves
    (b) with transistors and integrated circuits (solid state)
    (c) Valves and transistors (Hybrid)

3. Receivers (a) Single Band (usually medium wave coverage) (190-550 metres)
   (b) Multiband receivers (Medium wave and one to three short wave bands)
4. Receivers (a) Table Model
   (b) Portable Model
5. Receivers (a) with provision for external speaker connection
   (b) with provision for using as an amplifier with record player (pick up)
   (c) with connection for using with tape recorder for recording.

The following accessories may also be used with the Radio Receiver when necessary.

—External out-door aerial to receive remote distant stations
—Extension speaker or speakers
—Amplifier if more extension speakers are to be used
—Tape recorder for recording educational broadcasts for replay at convenient time.

Operational Controls

1. Power on-off switch—separate or combined with sound volume or tone control.
2. Volume control to increase sound intensity to the desired level.
3. *Tone Control*: This is not incorporated in all receivers. The purpose of this device is to modify the quality of sound output to desired quality. A bass sound can be made more pleasant by suppressing bass notes to a certain extent. Similarly a high pitched sound can be made less shrill by suppressing high notes.
4. Band change switch in multi-band receivers to select a particular wave length range.
5. *Tuning device*: This is the most important control in the radio receiver. By adjusting this device, the receiver is made to receive the specific station, broadcasting in a specific frequency. Fine tuning arrangements are made to facilitate more accurate tuning. When a station is perfectly tuned, rotating the tuning control in either direction will cause a reduction in volume.

Details of Educational Broadcasts in Tamilnadu

Name of Station	*Frequency & Wavelength*	*Time of Educational Broadcasts*			
		Ele. School	*Middle School*	*High School*	*Other levels*
Madras 1	720 kilohertz & 416.7 metres	11.40 a.m. to 12.00 noon	12.05 p.m. to 12.30 p.m.	2.10 to 2.35 p.m.	(University)
2	7160 K. Hz & 41·90 m.	11.40 a.m. to 12.00 noon	-do-	-do-	7.25 a.m. to 7.45 a.m.
Tiruchi	936 K. Hz & 320.51 m.	-do-	-do-	-do-	10.30 p.m. to 10.50 p.m.

Also—*Pondicherry*—283 M (1060 K Hz) *Coimbatore*—300 M (999 K Hz) and Tirunelvei 250 M (1200 K Hz) and similar Educational broodcasts for the other regions are arranged from AIA stations catering to these areas.

Most of the receivers marketed today have indoor aerials. Ferrite coils serve for medium wave reception and loop and collapsable telescopic aerials serve for short wave reception. In the case of sets having Ferrite rods for medium wave reception the set as a whole should be rotated for maximum reception. When the receiver is operated in places far away from transmitting station, a good outdoor aerial will improve the quality of reception.

The Radio as Aid to Teaching

The radio besides being a mass media of communication can also play a major role in imparting instruction to school children. Such of those broadcasts are styled as educational broadcasts. These broadcasts are made during specific days at specific school hours, mainly for the benefit of the educational institutions. These broadcasts are on curricular subjects based on the prescribed syllabus sequenced to synchronise with the class lessons. Educational broadcasts will considerably help the teacher to supplement his classroom instruction. The teacher should *prepare* the pupils so that they will be benefited to a maximum extent by listening to a specific broadcast. He should plan for effective listening and also prepare a suitable follow-up work for consolidation.

Booklets describing the details of programmes of educational broadcasts for the year are prepared and printed in advance by the All India Radio and made available to educational institutions at the beginning of each academic year. Programmes are arranged separately for the benefit of elementary, middle and high schools and for university correspondence course students.

1. The main aim of any broadcast for educational purposes should be to inspire the student to gain greater knowledge. This can be achieved by (a) broadcasting biographies of people who have contributed to advancement of knowledge in specific areas like Sir Isaac Newton, Charles Darwin, Michael Faraday, Sir C. V. Raman etc.; (b) broadcasting events which are important landmarks in history and that which revolutionised the thinking and life of man for example Industrial Revolution, French Revolution and Freedom Struggle of India ; (c) broadcasting about progress in science and technology, industry, practical results of such progress etc. Listening to such broadcasts will arouse the interest of the pupils and will create a desire to acquire greater knowledge and skill. The library, the laboratory and the workshop will be put to greater use and with an additional purpose in a meaningful way.

2. Listening to preview of a newly introduced commercial product, for example, a new model of a bicycle stressing its design, special features introduced for safety, economy and comfortable travel will be of good educational value. Broadcasts of reviews of

good books recently published will make the pupil know about the same and their special values.

3. Broadcasts could be made of recording of sound of a factory as the background superimposed with suitable commentary. Narration of details of conducted tours around places with suitable locational backgrounds will be very useful to give an idea of the tour. Suitable musical background makes the programme attractive and more realistic.

4. Listening to broadcasts of dramas, recitation of poems, narration of stories, readings and recitations from books, rendering of classical, instrumental and light music helps towards harmonious development of the mental growth of pupils and makes them fit as useful members of the society.

Limitations of Educational Broadcasts

The concepts gained through the sense of sight play a dominant part in the gain of knowledge. For comprehension and complete understanding visual information is necessary. Knowledge through the sense of hearing could be considered only secondary. Hence radio broadcast which has no provision for any visual experience cannot be quite effective in imparting knowledge completely. This is particularly so for teaching subjects like science, technology, etc., where it is necessary to use maximum number of visual aids ranging from the simple chalkboards to the most sophisticated closed circuit television. Further direct experience in the form of individual activity is more important in such areas to fully comprehend and realise the practical benefits of such knowledge. Although radio broadcast has all these limitations in not providing visual experience, it can provide a vista of knowledge to the classroom if properly organised.

Organising a Radio Lesson for Effective Listening

A. Preparation : Any teacher can know the complete details of the specific programme to be broadcast on any particular day by looking into the booklet on educational broadcasts supplied free of cost to all educational institutions by the All India Radio. The eacher can create a very favourable learning situation by suitable preparation, exposition of needed subject areas, supplemented by suitable aids, graphic and other projected aids whenever necessary.

B. Listening to the Programme : The radio is switched on sufficiently early. In the case of valve receivers, valves require 1-2 minutes of heating time. Correctly tune the station adjusting the volume of sound and tone control to the desired level. For larger audiences, a battery for extension speakers could be used, using an amplifier, if found necessary. The pupils are comfortably seated and the volume of sound is kept a little higher than absolutely necessary to create an atmosphere of authority. Programme could be recorded if replay is considered necessary and justified.

C. Feedback : To evaluate the learning outcome, suitable questions are posed and based on the reply, clarification is made whenever considered necessary. Discussion of the programme will also help evaluate learning outcome.

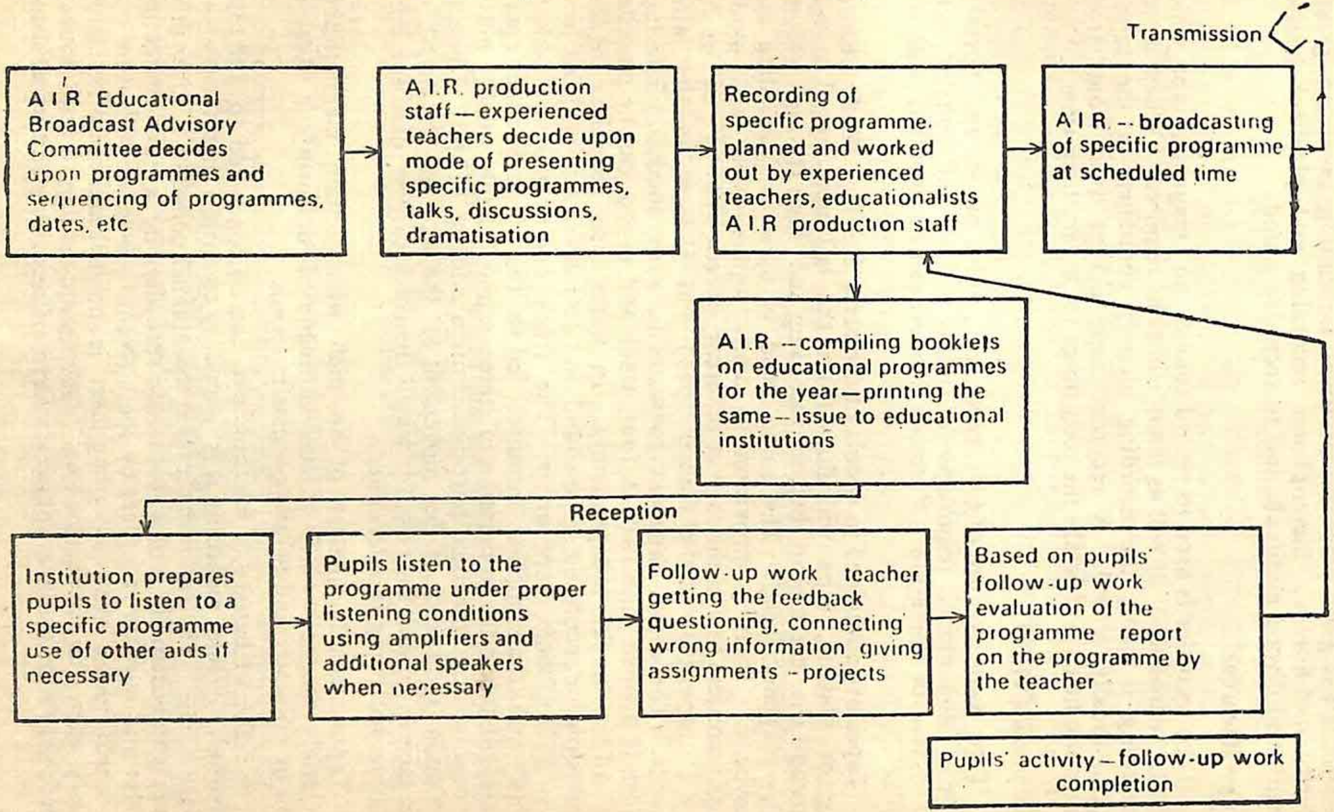
D. Consolidation : Follow-up work resulting in consolidation of acquired facts is done by giving written assignments for completion at home by pupils and directing them to suitable projects.

E. Evaluation Report : An evaluation report on any specific broadcast programme based on the feedback and results of completed assignments and projects by pupils should be prepared by the teacher and sent to the AIR. This will help them towards planning better programmes and presenting them differently. A programme evaluation format is also included in the booklet containing the programme details issued by the AIR.

An advisory committee consisting of senior teachers, headmasters, educationalists and officers from the Director of School Education guide the Station Director, AIR to arrive at an operating programme for the whole year. The comments offered by the teachers in the Evaluation proforma are considered for suitably modifying the programmes.

Record players : Like tape recorders, are means of audio playback. Of the two, record players are older types of hardware using records or discs for the needed playback. Four sizes of records 7″, 10″, 12″, and 16″ are in common use. In addition to the traditional 78 r.p.m., there are high speed records played with standard stylus. The record players now in use are equipped with speed changer mechanisms permitting the playing of the slower long-playing 45, 33⅓ and 16⅔ r.p.m. records played by microgrove stylus. The use of recorded pieces in education has much value in language learning, appreciation of poetry and literature and presentation of brief dramatised episodes from history, not to mention development of musical knowledge and discrimination. Long playing records with 20 minutes of recorded information per side provide several diverse selections inscribed on each side and are most suitable for classroom instructional purposes. The needed selection for a particular learning situation can be easily identified by the specific microgrove ring it occupies on the record. 'Talking books' for the blind also consist of recordings of essential literature for the visually handicapped. The older, manually wound spring powered gramophone has now become practically obsolete, its place now taken up by electrically powered multi-speed record players and changers with built in amplifying unit or linked to separate amplifying units and speakers. So also, the older mechanical

Flow Chart of Educational Broadcast Programmes


Transmission
A I R Educational Broadcast Advisory Committee decides upon programmes and sequencing of programmes, dates, etc
A.I.R. production staff—experienced teachers decide upon mode of presenting specific programmes, talks, discussions, dramatisation
Recording of specific programme, planned and worked out by experienced teachers, educationalists A I.R production staff
A I R. -- broadcasting of specific programme at scheduled time
A I.R --compiling booklets on educational programmes for the year—printing the same-- issue to educational institutions
Reception
Institution prepares pupils to listen to a specific programme use of other aids if necessary
Pupils listen to the programme under proper listening conditions using amplifiers and additional speakers when necessary
Follow-up work teacher getting the feedback questioning, connecting wrong information giving assignments - projects
Based on pupils' follow-up work evaluation of the programme report on the programme by the teacher
Pupils' activity—follow-up work completion

recording has given place to electrical imprinting involving greater clarity and fidelity. Stereophonic recording and playback provide depth and diverse audio channel to recorded sounds.

Tape Recorder

Tape recorder is used to record sounds on magnetic tape which can be reproduced at will as many times as required. When a new recording is made, the recording already contained in the tape is automatically erased. A recorded tape if kept away from strong magnetic fields will retain the recordings for a very long time.

Technical Details

Tape recorders are of two types, viz., table model and portable type. Table models require power supply of 230—240 volts of A.C. 50 cycles, for operation. Portable models can be operated with dry cells.

Tapes are contained in spools of diameter 5″—7″. While recording or playing, tape will flow from the left hand spool to right through the erase head before recording and then through recording—playback head. The same head is used for recording and playback. There is provision in many sophisticated table model tape recorders to run the tape at different speeds like 1⅞″, 3¾″ or 7½″ p.s. ⅛″ tapes play in the former speed and ¼″ tapes in the latter speeds. There is a tape run indicator in many models. The tape width is divided into two or four track and sound can be recorded on all the tracks independently. In some tape recorders there is provision for recording same sound on two tracks, using signals from two microphones kept apart. The tracks can be played simultaneously and the amplified impulses fed to two speakers kept apart. This will create the impression of stereo sound. High quality music recording for commercial purposes is often done at 15″ p.s. Depending upon the speed of the movement of the tape and the length of the tape in spool, the time for which the track can be used for continuous recording is determined.

Tapes, usually quarter of an inch wide contain magnetisable materials (magnetic oxide of iron) impregnated uniformly in Acetate film or polyester and wound on plastic spools.

A single or battery of microphones can be connected to the tape recorder. While recording it is necessary to ensure that there is no overloading. The recording level is maintained constant. Recording level is indicated in professional deck recorders by a level-indicating meter and in other recorders by inert (Neon) gas lamp indicators one of which glows when recording level is normal and the other lamp glows when there is overloading. Overloading is due to loud sounds made very near the microphones. Level of recording can be adjusted by adjusting recording level control and playback volume control ir same recorder.

The quality of sound can be modified by using the tone control. It is necessary to monitor the recording throughout to enable listening without the necessity of continuously operating the controls.

When recording is completed, the portion containing recording would be in the right hand spool. To play the recording, the tape should be brought back to left spool. If any portion is not to be listened the same should be transferred to right spool. The tape transfer from spool to spool in the 'wind on' and 'wind back' position is very fast. But during recording or playback, the tape is moved at the particular set speed.

Various Controls : The controls in a table model tape recorder are as follows :

—on/off switch combined with volume or tone control

—volume control (playback)

—tone control (playback—recording)

—recording volume control (level control) kept separately in some recorders

—recording level indicator

—wind on or Forward fast tape movement control

—wind back or reverse fast tape movement control

—record—press switch or othei type

—playback—press switch or other type

—pause provision—enables movement of tape to be arrested and released at will during recording or replaying.

In addition to these, provisions for microphone input and external speaker output are usually made in all tape recorders. In special types, there is provision for low impedance input and output for external amplifier also. Some tape recorders can be used as amplifiers.

The quality of recording will depend upon :

(a) the nature of microphone used (dynamic or velocity, etc.)
(b) the method by which it is used (whether shielded cable is used or whether there is impedance matching, etc.)
(c) level of recording (recording at higher than normal level will result in distortion)
(d) the speaker used.

Portable tape recorders can be operated with dry cells or directly from 230-240 A.C. volts. Portable tape recorders now have incorporated highly sensitive condenser microphones in them. These microphones pick up easily feeble sounds from even twenty feet. There is also provision for using external microphone. There are the usual push button controls like wind back, wind on, record, playback, and eject tape. All portable tape recorders have provision for remote operation. In addition to volume control, tone control facility is also available in some tape recorders. Portable tape recorders have provision for individual ear phone. They have now indicators for the tape run. Tape is run at single speed with two tracks. The tape used is in a cassette. This eliminates the need for feed spool, take up spool and also the need for passing carefully the tape between recording-playback heads. The cassette is pressed in position and automatically the tape goes between the heads. Pressing a key ejects the tape when it has been played. Cassettes are available in two tracks C 15, C 30, C 60 and C 90 and the total running time corresponds to 15, 30, 60 and 90 minutes.

Operating the Tape Recorder : Almost the same steps are followed for both Mains operated and Portable sets.

1. Put full tape spools in the left side holder shaft (Feed).
2. Pass tape carefully between recording—replay heads—capston roller to take up spool on right hand side and fix end to spool.
3. Connect microphone by shielded cable to input.
4. Switch on power. Power indicator lamp will glow.
5. Fix tape speed—lower speed for talks and higher speed for music.
6. Note tape run indicator.
7. Press or rotate switches, Record and Play for recording.
8. Make sounds, run tape and adjust level for trial recording to help in actual recording. Adjust volume, tone to get recording at normal level.
9. Wind back the tape till the tape run indicator gives the same reading as at start.
10. Press playback switch, increase volume and tone to the required level. Listening to this playback will serve as guidance for microphone position, volume control position, tone control position during actual recording.
11. Wind back to start of tape.
12. Record with knowledge gained by trial recording and playback.
13. Any recording should be played back at the same speed in which it was recorded.

Tape Recorder Operation

1. Press cassette in position.
2. Switch on if power supply is from 240 V-50 AC mains, the battery connection is automatically disconnected.
3. Press wind-on key so that all the tape is wound on left side.
4. If the tape recorder does not have an built-in condenser microphone, plug in external microphone.
5. Press record and play keys down.
6. Talk before the microphone, keeping mouth about 1-2 feet from microphone.
7. Adjust recording playback volume so that level indicator shows normal recording level provision incorporated.
8. Press the wind-back key so that the portion of tape containing recorded sound is brought back to the left side.
9. Press 'playback' key—increase sound volume to the desired level.
10. When the entire tape has gone to right side, eject the cassette by pressing ejector key.
11. Press cassette again after rotating the same so that the other face is pressed down.
12. Proceed as before.

Educational uses of Tape Recorder

Following are the uses of tape recorder for educational purposes :

1. Tape recorder can be used to record educational broadcasts and for replay at suitable and convenient time.
2. Tape recorder can be used to record music and other sound effects for use during staging of dramas in schools and cultural performances.
3. Tape recorder can be used to record the talk of some important visitor to the institutions and can be effectively used later.
4. Tape recorders are very largely used in language laboratories for giving speech training and for correction of pronunciation defects. Recordings of model talks by teachers or experts in the language can be frequently used. Pupils' talk can also be recorded and played. The mistakes may be pointed out during replay.
5. Tape recorders can be used for teaching music.
6. Instructions for doing experiments or any activity can be recorded on cassette and the individual can listen to it by

ear phone and do the necessary operation without disturbing others. Audio-tutorial set consisting of booklets, books and equipment for doing simple experiments may be prepared and kept in audio-tutorial booths for use by individual pupils in various subject areas. Instructions are recorded in the cassette and with the help of ear phone, the student listens to the instructions and makes use of other materials simultaneously.

7. Commentary to filmstrips can be suitably recorded on a tape recorder and the tape may be played back while the students view the filmstrip pictures projected on the screen.
8. In teacher training institutions, a tape recorder can be very effectively used during the 'Micro Teaching' sessions. The tape recorder will provide the necessary feedback for discussions to improve the lesson.

Maintenance of Tape Recorder : Switches should be gently operated. Particular care should be taken in the operation of push button switches. Tapes should be kept wound evenly on spools. There should be no twist in the tape between the spools. The correct side should face the heads. The heads should be kept free from dust, dirt etc., by periodically cleaning with a camel hair brush. Owing to frequent use, the head may get permanently magnetised. It will be necessary to demagnetise the head. Tape recorders are precision equipment and should be treated as such.

Language Laboratory

Language laboratory is a very popular technical innovation. It is derived from America, although its use had gained ground rapidly in the United Kingdom in 1960s. Language laboratory affords opportunity for the students to hear the language spoken by a native and to practise speaking the language themselves. Traditional language teaching does not allow much time for oral and auditory experience and in this respect, the language laboratory is an innovative technique.

Objectives of Modern Language Teaching

The function for language is to communicate ideas. Today the aim of the good language teacher is to teach his students to communicate successfully with the native speaker of the language. Otherwise stated, language is a medium for communication and hence the ability to communicate in the language concerned is now emphasised in language instruction.

The purpose of language teaching is to enable the students to *understand, speak, read* and *write* the foreign language with the native speed. The order in which the language skills are presented is hearing, speaking, reading and writing. This sequence emphasises the essential feature of language, i.e., reliance on printed words is eliminated until mastery of sound is achieved.

One other objective for language teaching is to enable pupils to speak with correct intonation, pronunciation, accent and fluency like an educated native speaker in normal conversation. This objective is too difficult to realise fully.

Need for Language Laboratory

The most important advance made in language teaching is the language laboratory. Language laboratory recognises the prevalence of wide-spread individual differences in language aptitude even among the average and superior intelligence. It is essentially individualistic in its approach.

The language laboratory recognises that the spoken form of language is central to the effective communication. Spoken form should have a large share along with written forms in language teaching. The language laboratory implements this programme by supplementing the sound recordings of native speakers with the text book.

The only realistic purpose of the language laboratory is to provide a convenient means of hearing and responding to audio-drills. Well designed and carefully produced pattern drills can be easily recorded and used in the laboratory. The language laboratory thereby relieves the teacher of endless repetition of patterns.

Functions of the Language Laboratory

A language laboratory is fully equipped if the *student* can

(a) hear the tape distinctly,
(b) stop, rewind and replay the tape at any time,
(c) work at his own pace,
(d) select his materials freely,

and if the *teacher* can

(e) listen to individual students without disturbing them,
(f) communicate with the student,
(g) control the programme when he so desires.

The typical complete language laboratory provides separate booths, one for each student in the class. Each booth is equipped with ear phones, a microphone and tape recording and playing equipment. The teacher controls the class from a *console*. The console has one or more tapes with master tapes and special equipments to 'monitor' any student and thereby two-way communication is ensured.

The normal teaching sequence is as follows : The teacher first plays a master tape. The sounds are picked up and recorded on the separate tape recorders kept in each booth. There is no possibility to stop the tape and repeat the difficult parts. This is called *lockstep* learning and has no opportunity for individualisation of programme selection or control.

The student then listens to his copy of the tape and at specified stages makes oral responses to it. These responses are recorded by the recording equipment in the student's own booth. Each student can go back over his copy of the tape as many times as he requires, listening to both the pre-recorded material from the master tape and also to his own responses. If he is not satisfied with his own response, he can also record and improve his previous performance.

The student's tape recorder uses *twin track* tape. The master tape is recorded on one of the tracks and the student's responses are recorded on the other. The material on the master tape has pauses left in it which give him enough time to respond. In playing back, the student listens to the original material and also his own recording responses. In both recording and re-recording by the student, the master track remains untouched and cannot be recorded over. This type of programme is normally used in the initial stage for correcting pronunciation. The exercise is called '*speech drill*'.

In all the speech drills, the following order is observed :

Master track	Stimulus I		Stimulus 2	
Student track		Repetition 1		Repetition 2

Laboratory Operation Procedures

Four principal procedures are in use, each requiring somewhat different equipment. The differentiation among the procedures is based on the degree of freedom given to the student in selecting the tapes and working individually.

1. *Broadcast Procedure* : This is the minimal basic system and least expensive. There is a console from which the teacher distributes the programme. Students have no option in deciding the programme. The teacher alone decides the complete programme.

2. *Library Operation :* This enables the student to select anyone of the tapes from the central place. He takes the tape to his booth and plays for his own benefit regardless of what others are listening. This permits true self-pacing and self-correction by retracing. This

form of operation permits maximum individualisation. The versatility of this procedure is limited only by the high cost. This arrangement requires tape recorder for each student, a large stock of prerecorded tapes, isolation booths for every individual and special maintenance rooms.

3. *Dial Access* : This system provides automatic, instantaneous selection of lessons by a telephone type dial or *touch-tone*. The student receives a broadcast from one of many remote automatic sources by dialling a code number from his booth. He can practise in this form but cannot stop the tape to replay portions, as in the case of 'library operation'. By coupling a student booth to an individual remote student deck, a copy of the broadcast lesson is transferred to the control of the student. He may then work at his own speed and retrace.

In this operation, only the student who dials first will hear the tape from the beginning and receive the explanatory instruction. A student arriving five minutes later and dialling the same number will also join the programme already in progress at that point. Majority of the students will come in the 'middle of the show.'

4. *The Combination :* This is a broadcast laboratory in which a certain percentage .of booths is provided with individual tape decks. These fully equipped booths can be used as a library operation while the main part of the laboratory goes with the broadcast programme.

Special Features of the Language Laboratory

(a) *Retracing :* Language consists of a set of habits which have to be acquired through much imitation and practice. Hence in intensive drill practice, student should be able to stop the tape, hear again the sounds and to practise them by imitation as often as desired. In programmed instruction, the student cannot advance until he has mastered the previous frame. But in language laboratory although the programme is linear, the next step automatically appears irrespective of the success of the student in the previous frame. The student must himself determine whether he has performed accurately. If he decides that he has not, the student must be able to repeat the defective frame until he succeeds. This is called 'retracing'.

(b) *Self-pacing* : In a language laboratory, every student works at his own speed. A slow worker would be one who does much retracing and who spends much time on a tape. A fast worker would do less retracing.

(c) *Material Selection* : In a basic language laboratory, no selectivity is provided to the student. In other laboratories, the student may select and use tapes individually as explained in library operation.

(d) *The Console :* This is the control centre where the instructor's equipments are located. It has the following switches;

(i) *Distribution switches* : To direct the recorded programme to the selected student booths.

(ii) *Monitoring switches* : Monitoring enables the teacher to listen to any individual as he works with the tape. It is done for

—correcting errors in procedure
—correcting linguistic errors
—evaluating and grading the students.

(iii) *Intercom switches* : To permit a two-way conversation with any individual student.

(iv) *Group-call switch* : Enables to make announcements to all students who are listening to a particular tape from a console source.

(v) *All-call switch* : For making announcements to all students in the laboratory, regardless of the nature of the programme.

Advantages of a Language Laboratory

The following are the specific advantages claimed for language laboratory over conventional classroom method.

(a) The student listens to perfect native speech rather than the less-than perfect speech of the teacher

(b) The students' active speaking time is increased considerably.

(c) Since the student is not being listened to by other students when he is practising, he is likely to be less inhibited than in a normal classroom.

(d) The student can hear his own mistakes for himself.

(e) The teacher by monitoring the programme, can give individual instruction without disturbing the whole class.

(f) The teacher is relieved from the chore of presenting routine and repetitive practice material. He has now more time and energy to devote to the particular needs of individual students.

Audio Cards : Today, particularly in language learning involving active building of vocabulary, *audio cards*, either pre-printed and pre-coded or blanks on which the needed information may be recorded, are coming into use. Each card accommodates a very short (about 5 seconds) audio message. The audio card consists of a rectangular card on which a small length of audio tape is permanently attached on the lower portion providing the sound track for the word, sentence, question or picture printed on the top portion. Here when the card moves across the magnetic head of the word and in playing back compare his pronunciation with the original and correct himself. The card reader can be applied to learning basic maths and science concepts also and is most suited for individual learning.

Tele-Lecture

Tele-Lecture represents a means of conducting off-campus courses in number of widely scattered sites through the use of tape recorded lectures and amplified telephone calls, with the professor remaining on-campus for all of the class sessions. Tele-lecture can be offered in any community that has telephone service. Instead of the instructor travelling to various places for meeting a fixed number of students as is necessary for an off-campus class, tele-lecture can combine a number of small classes.

Each week participating classes receive by mail a one or two-hour taped lecture. The taped lecture is played at a class session arranged by the class at that site at a time and place convenient to the group. In addition, each week at a designated time all participating classes meet at a designated spot. They are connected by an amplified telephone call to the professor on the campus. This call will last for 50 minutes and is used to answer questions, clarify lectures, or supplement to the lecture material which was taped. Two-way communication between students and the professor is thus provided. A student moderator can control the microphone placed in the class. Tele-lecture can benefit high school students also for they can interview a local businessman and get vocational guidance by this method. One class member in each site is designated as the "On-Site Course Assistant". He is responsible for registration, taking instructions from the course director, receiving tapes, administering tests, returning all materials to the college and carrying all necessary communications with tele-lecture co-ordinator in the campus office,

When a video-tele-lecture can be arranged, closed circuit television aids an extra dimension. Students can see the speaker as he answers his questions.

Sound Systems

The function of a sound system is to reproduce at a different place or places the sound made at one place. The reproduced sound is usually louder than the original sound. It is necessary that the reproduced sound differs from the original only in loudness or intensity. The quality of reproduced sound should be identical with the original. Distortion should be absent under ideal conditions, but such a condition cannot be realised in practice. Cent per cent fidelity of reproduction is not possible. Hence as high a percentage of fidelity of reproduction is aimed at and technical advance in design of elements of sound system is aimed to achieve as high percentage of fidelity of reproduction as feasible. (High-Fi reproduction).

In many cases High-Fi reproduction is not essential and it will be enough if the reproduced sound clearly conveys the message. But in reproduction of music, particularly, High-fi reproduction is essential so that there is *only* change of intensity in the reproduced sound.

The essentials of a sound system are (a) microphone or microphones (b) Amplifier (c) Loud speaker or speakers (d) other accessories like switching controls, mixing controls etc. Power to operate a sound system is from either 230 V A.C. Mains or 6 or 12 Volt car battery.

Microphone

Sound waves cause the diaphram of the microphone to vibrate and these vibrations of the diaphram, which is corrugated and made of thin duralumin, cause the moving coil attached rigidly to its centre to vibrate. The coil is located in the radial field created by a powerful permanent magnet. The vibration of the coil in this radial field induces an e.m.f. The variation of induced e.m.f. is in accordance with induced sound. Microphone generates a varying electromotive force, varying according to sound incident at the microphone. The microphone described is the moving coil microphone. There are other types of microphones; but any microphone is a transducer"—converting part of sound energy into electrical energy. The moving coil microphone is mostly used in sound systems.

The other types of microphones are (ii) carbon microphone (now used only in telephone), (ii) Condenser microphone, (iii) Velocity microphone, and (iv) Crystal microphone. Condenser and Velocity microphones are used in broadcasting studios.

Microphones can be classified according to their impedance as low impedance of the order upto 30 ohms and high impedance—600 to 1000 ohms.

Microphones are also classified according to their directional sensitivity—unidirectional, bi-directional and omnidirectional.

Microphones are used mostly fixed to stands which may be a table or a floor stand. If excessive movement of the speaker is necessary and inevitable, microphones attached to cords over neck are used. Hand-held microphones have come into vogue during light music concerts given now by young musicians.

Many microphones have transformers incorporated in their outer casings. Switching arrangements are provided for high or low impedance output connections and also on and off (shunting microphone output) provisions.

The varying e.m.f. from the microphone is fed to the amplifier by special flexible coaxial cable consisting of one cord or two cord cable surrounded by a conducting shield of woven thin copper wire clothing. The shield is connected to earth. The use of shielded cable ensures that no stray electrical pick up other than e.m.f. from the microphone is fed to the amplifier. Loose connections at either microphone end or the amplifier end of the cable will cause unpleasant noise. This is prevented by rigid soldered terminations of the microphone cable to jacks (connectors) and kept rigid by screwing provisions at either end. It is necessary to have a long single cable. Extension of a cable should be avoided but if necessary, should be done by a proper connector.

Amplifier

The purpose of an amplifier is to amplify the varying input from the microphone to suitable levels. The output from an amplifier is fed on to a loud speaker or loud speakers. The nature of the output is to provide varying electric current varying in consonance with the input e.m.f. The amplitude of variation in current output causes the corresponding movement of diaphram of the loud speaker or loud speakers connected and sound is reproduced. The intensity of sound reproduced depends upon the amplitude of vibration of the speaker diaphram. The intensity of sound could be controlled by gain control in the amplifier, i.e., volume (sound) control.

Amplifiers can be classified according to nature of amplifying elements used, namely Valves or Transistor (solid state).

Most of the amplifiers available could be operated using 230 V A.C. Mains or 6 or 12 Volt automobile battery.

Amplifiers have provision for use with single channel (input) or two or more channels from microphones and provision for use with pick ups (gramophone or record player etc.)

The gain control for each input is separate and this provision ensures the proper use of more than one input channel (microphones). The output is of course mix-up of inputs amplified to suitable controllable levels. Other controls provided in an amplifier are Tone control or controls.

Any body vibrating produces sound. The sound is carried to our ears by air. The frequency of sound is identical with that of the vibrating body. For the sound to be perceived by the human ear as sound, the frequency of sound produced should be within the limits of audibility. The lower limit of audibility of the normal human ear is about 30 vibrations per second and the upper limit is about 20,000 vibrations per second. Sounds which are encountered are often complex in nature and are made up of different frequencies and varying amplitudes. If the major components are of low frequency, the resulting sound will be low of frequency. (bass sound). If higher frequencies dominate, the sound will be shrill (treble). The quality of sound will depend upon its composite nature. Too much dominance of low frequencies (bass) or high frequencies (treble) will make the sound not very pleasant to hear. A highly bass sound could be modified to make it more pleasant to hear by passing high notes. The sound is only modified and not completely changed. This is tone control. Some amplifiers have separate controls for bass and treble. The controls in an amplifier are either rotary or linear.

The capacity of an amplifier is also an important factor. The capacity of an amplifier is denoted by the power output—5 watts, 10 watts, 15 watts, 20 watts, 25 watts, 30 watts, 40 watts, and 60 watts capacity amplifiers are now available. It is necessary to connect with an amplifier loud speaker or speakers which can handle the output. For example, if a loud speaker which can dissipate 10 watts is connected to an amplifier which can deliver maximum output of 25 watts and if the gain (volume control) is fully turned during the operation, the result will be a damaged speaker.

The body of the amplifier should be properly earthed. This is important if Mains 230 V A.C. is used for operation. The body of the amplifier is usually in connection through the shield of the microphone cable to microphone body and stand. Unless the body (case) is at earth potential there is a possibility of the person using the microphone receiving a shock.

The output from the amplifier is brought to the terminals 4 ohms, 8 ohms, 16 ohms, 32 ohms or 100 volts, 50 volts etc. (Philips). The connections to loud speaker or loud speakers should be made of good quality insulated wires of suitable gauge so that the effective impedance of the loudspeakers is equal to (matches) output impedance. For example, single 4 ohms speaker to be connected to 4 ohms, two 4 ohms speakers to be connected in series to 8 ohms etc. of course, the output voltage should be for safety less than the capacity of speaker.

Loud Speaker

The vibrating diaphram of the loud speaker reproduce the original sound amplified.

The moving coil loud speaker which is identical with the moving coil microphone in constructional details differs in the fact that a stiff paper cone with corrugated edges is the vibration source. A rigid coil is attached to the centre in a radial magnetic field provided by very powerful Alnico or ceramic magnets. The varying current from the amplifier out-put moves the coil to and fro and the attached paper diaphram vibrates reciprocally.

Speakers are made with either circular diaphrams or elliptic fronts. They are made in various sizes from 4 to 30 cms of circular or elliptic fronts. The speakers are made for different capacities for producing sound intensities—200 milli watts to giant speakers of 15 watts. Speakers are housed in suitable sized cabinets. Special speakers to reproduce bass sounds (woofers) mid-range sounds and high frequency sounds (Tweeters) are incorporated in Hi-fi speaker systems.

It is always desirable and necessary to distribute the sound to a number of smaller speakers than one large speaker blasting aloud in the room. Column speakers are made by arranging a number of speakers in a line inside a cabinet. Connections are made to ensure synchronisation in movements of their diaphrams. The column speaker is highly directional.

The unit speaker and the exponential horn is used outdoors. It is made with capacities 15, 25, 30 watts, etc. The unit speaker also is highly directional. Since the vibrating diaphram is made of metal, reproduction will be partial to higher frequencies. For outdoor events like sports etc. unit speaker is ideal.

Public Address System

Public Address System is used in educational institutions during functions, celebrations, meetings, etc., where the entire institution is involved. For normal classroom (maximum strength 30—40) no public address system is necessary. The use of a table or floor stand for the microphone restricts the movement of the speaker or teacher using the Public Address System in a large class. A neck microphone may be used in such cases but the trailing cable may be a source of irritation.

The fidelity of reproduction also depends upon the accoustics of auditoria. Outdoors may not present any problem but indoors the design of auditoria becomes important. For very good reproduction the walls should be treated with absorbing porus material—glasswool, perforated joly board, etc. A thick curtain located about 15 cms from the wall will be sufficient. All windows and doors should be kept open or fitted with curtains. The accoustic correction of rooms is not absolutely necessary for normal routine institutional functions or large class instructions. The steps involved in arranging a Public Address System include the following :

1. (1) A microphone or microphones used to provide input.
2. (2) Table or floor stands are used, if hand held or neck microphones are not used.
3. (3) Proper connections are made to the amplifier using shielded cables and connectors and the amplifier is earthed.

(4) The amplifier is connected to power supply with the gain controls at minimum position.

(5) It is desirable to connect the output of the amplifier to loud speaker or speakers matching impedance and keeping in view the amplifier wattage and capacity of speakers.

(6) Column speaker or speakers could be used to advantage. These provide directional sound.

(7) The amplifier is switched on. After heating up time (valve amplifiers) the gain control to different channels is increased till a faint hum is developed. Further increase of gain control will result in a shrill sound (Feedback—sound incident at the microphone is amplified—the amplified sound reaching the microphone is further amplified→and so on). Feedback could be minimised by using a unidirectional microphone.

(8) To reduce feedback and to increase sound level in the room, the following steps will help.

  (i) Loud speaker should not be near the microphone facing it.

  (ii) Loud speakers should be located near windows.

  (iii) Distribution of sound through several small speakers or using column speakers will help.

(9) The speaker should talk or sing with lips about 20—30 cms from the microphone. Speaking into the microphone with lips almost in contact or very near the microphone will cause large distortion in reproduced sound.

(10) The tone controls may be used, if necessary.

(11) The amplifier should be located in a position accessible only to operator normally. This will ensure that no stray operation controls will result by extraneous persons, meddling with them.

(12) The operator monitors the controls, increasing or decreasing the gain in the channels adjusting them to suit the purpose.

(13) Sometimes a record player is connected to the amplifier for playing soft music, preferably instrumental at low volume before start of functions and for playing National Anthem at the end.

(14) For outdoor functions, unit speakers are to be located at proper positions with reference to height, location and orientation.

The speaker or the teacher should be aware of the fact that proper selection of loud speakers, distribution of speakers in the hall and the location of the same are very important to effective listening and comprehension.

For example, a 20 watts amplifier feeding a number of speakers located properly in a hall with a seating capacity of 500 will be adequate for all purposes. Unfortunately, many go in for large capacity amplifiers unnecessarily involving avoidable cost.

A moving coil loud speaker (15 cms) suspended over a stage of moderate size connected to an amplifier through an output transformer will be able to pick up sounds below and could be used whenever necessary for stage performances.

A microphone is a sensitive instrument and as such should not be subjected to vibrations like tapping on it, etc. Testing could be done by talking normally before the microphone.

Central Sound System

Many institutions have loud speakers located in all classrooms. These loud speakers are connected by suitable connectors and using line matching transformers to switching control located at a central room (Head of the Institution's room). The amplifier and microphone are located in the room. The Head, whenever necessary, could communicate with persons in any room or radio programmes could be connected to any room. This could be used as two-way communication system also. From the control room, the happenings in any room could be heard using the located loud speaker as a microphone.

Intercoms : There are communicating systems which are transisterised, operating on dry cells with one master and several talk-listening stations. These are easily available now and help in quick communication within the institution saving time and effort.

Educational Television

Television should be considered as the most exciting and efficient means of mass communication created by human endeavour in the field of pure and applied sciences. Unlike radio broadcast where only the sound is transmitted, television transmission has the added advantage of the all important visual experience which is made more dynamic and meaningful by the movement and sound associated with the visual experience. Television is a powerful agency of communication. Next to the home and school, television has a more profound influence on the education of a child and its impact is now begun to be felt in our major cities.

Live programmes and motion pictures can be broadcast in television. The vast potentialities of the facilities of the T.V. studio, the possibility of mixing images from two or more cameras fitted with zoom lens, super-imposing images, fading, cutting, etc., can be used to advantage in television. Television has all the advantages of a projected aid and the dynamism of motion picture. People can view and listen to a production richly blended with all that are useful. To produce an effective programme of fifteen minutes' duration, preparation of script by a specially trained educationalist, a number of rehearsals involving the assistance of various personnel like producer, assistant producer, vision mixer, floor manager, art floor manager, camera men, and recording in the Video Tape recorder of the final programme are the various steps that should be gone through before broadcasting the programme. Since the programmes are announced earlier, the institutions can prepare the pupils in advance to view and listen to the telecast. T.V. provides multimedia learning Experience.

Development of Television

The simple scanning disc has been replaced by the image orthicon, plumbicon and plumbicon colour television camera with zoom lenses so that the field covered can be varied as desired enabling long shots and close-ups to be televised. Sometimes a battery of cameras located at different points are used to cover the same event. It is possible by the monitor of the programmes to select signal from any particular camera and telecast the view. The rapid strides made in the field of electronics has made it possible to project the image from an ordinary television receiver on to a screen of auditorium size. In this way, school television may in the near future accommodate a much larger group than could be accommodated in front of the screen.

Instructional Television (ITV)

Many broadcasts, in addition to programmes exclusively for schools can be considered educational in a general way and viewed by pupils with advantage. Hence Educational Television (ETV) includes programmes whose primary interest is to educate rather than entertain. ETV generally includes instructional television and non-commercialised television programmes.

Instructional television (ITV) includes programmes related directly to an organised programme of formal instruction and are directed to individual viewers who come under non-formal education programme. In all these cases, suitable follow-up work by the teacher is essential to consolidate the gain of knowledge.

Television Transmission

The range of a T.V. transmitter is limited. . The range of the present T.V. transmitter at Madras is about 150 kms. Though reception at longer distances sometimes is possible, reception cannot be considered reliable. T.V. signals could be cut off by intervening hill or tall structure.

Television transmission is done using very high frequency waves. The Madras T.V. Transmitter is broadcasting (channel 4) with a frequency of 62.25 mega Hertz for vision and 67.75 mega Hertz for sound. These electromagnetic waves of very high frequency travel with the same speed as that of the other electromagnetic waves. Using waves of still higher frequency and reflecting the waves from an artificial satellite in space, the range can be increased. The artificial satellite must be placed in constant position relative to the earth. This is called the Satellite Instructional Television Experiment (SITE) programme in which Television is used as an effective media of mass communication in remote and backward areas. Range of T.V. operation can also be enlarged by locating suitable relay station at the border of reception area.

Principle of Television : In television, 25 pictures are formed in one second, in sequence, to create the illusion of motion. Each picture or frame is divided into 625 lines made up of points of differing intensity. A very thin electron beam of high intensity is accelerated towards the fluorescent screen. After suitably deflected by current in coils, the beam produces a luminous point of varying intensity on the fluorescent screen. The moving point produces an illusion of continuous movement. This illusion of motion is created partly due to small persistence of vision. The modulation to produce the desired visual is done on the vision carrier. The sound is carried on the sound carrier which is frequency modulated.

Television Reception : For good reception of television broadcasts, a good Aerial is necessary. The aerial usually is called the Yagi antenna. There is a reflector kept behind and one to three directors kept before the dipole. The aerial is located as high as possible. Lead from the dipole is brought to the receiver using special flex wire—minimum capacity (two stranded conductors) kept about 1 cm apart by insulating material). Aerial should be rotated so that the directors face the transmitting aerial to get maximum signal input.

Classification of T.V. Receivers : Television receivers are classified on the following basis.

1. According to size of screen—T.V. picture aspect ratio is 4 : 3. The receiver size is mentioned by the dimensions of the diagonal of the screen.

2. According to use of a (a) Valves,
(b) Transistors—Integrated circuits,
(Solid State), (c) Valves, Transistors

and Integrated circuits (Hybrid circuit.)

3. According to number of channels : Single channel or Multi-channel. Channel is similar to band in radio receiver. Multi-channel receivers have upto 12 Channels.

4. Portable receivers : Some portable receivers have twin telescopic aerials which could be rotated and oriented in any desired direction.

Controls in a T.V. Receiver

A. Operating Controls : (Controls may be linear or rotary)

1. On or Off Power switch
2. Sound Volume control
3. Brightness control
4. Contrast control
5. Channel Selector
6. Fine Tuning
7. Horizontal hold control
8. Vertical hold control

B. Other Controls : (to be operated by a qualified and trained technician)

1. Height control
2. Linearity control
3. Automatic gain control.

All T.V. receivers are normally mains operated. The performance of the receiver will be affected by variations of mains voltage. A receiver can be damaged by exeessive surge in voltage. Hence it is necessary to use a voltage stabiliser of suitable capacity which will keep the applied voltage constant at 230 volts though the mains voltage varies between 180—260 volts.

Operation of T.V. Receiver

The antenna is located as high as possible and it should be possible to rotate the antenna along a vertical axis to direct the same to get maximum signal. The lead-in should be brought without any coiling in the middle and connected to receiver.

Location of the receiver is also important. There should be adequate ventilation on all sides of the receiver. Ideal location is at a corner of the room separated from the wall by at lerst 25 cms. The receiver may be kept on a rigid table 2′—3′ high for comfortable viewing. No direct light through a door or window should fall on the T.V. screen. Exposure to bright sunlight of the T.V. screen may affect its performance. The receiver should be kept in a cool place and dry. The T.V. receiver should be in perfect adjustment. It is not desirable to open the back and make any adjustment by a person not trained in T.V. servicing.

The operating procedure consists of the following steps.

1. Switch on power.
2. In the case of hybrid and valve receivers, the sound and picture will result only after some time as the valves have to be heated up. In Solid state receivers, there will not be any delay. Adjust fine tuning to get a good and stable picture.
3. Adjust brightness to desired level.
4. Adjust contrast to get the required sharpness.
5. Adjust sound volume to desired level.

If there is tilted picture or movement in horizontal direction, adjust horizontal hold to steady the picture. Similarly movement in the vertical direction could be corrected using the vertical hold.

T.V. Viewing

Assuring effective viewing conditions as well as learner involvement and response are essential to get the most out of E.T.V. T.V. Viewing should not be done in total darkness; Vision will be impaired particularly in the case of children. The viewer should not be at a distance of less than six times the diagonal of the screen, i.e., for a 50 cm receiver, the minimum viewing distance should be 3 metres.

It is always better to have 3 or 4 sets installed in various places in the classroom. They should all be mounted above the heads of the seated pupils. The sets should be slightly tilted downward to reduce glare.

Pupils after viewing a particular programme should be made to get involved in follow-up activities like written tests, home assignments, related project work etc. The teacher's responsibilities in E.T.V. include arranging suitable physical climate of the classroom, meeting individual pupil needs, preparatoy activities before programme commences, activities during the programme and follow up activities after the tele lesson.

Instructional Television Programme

Educational Television and ITV can be used in three basic ways :

1. *Total TV Teaching* : T.V. is the only teacher in the classroom.

In a way, the programme replaces the teacher. Such an use of T.V. is seen in the education of children in very remote areas not covered by schools.

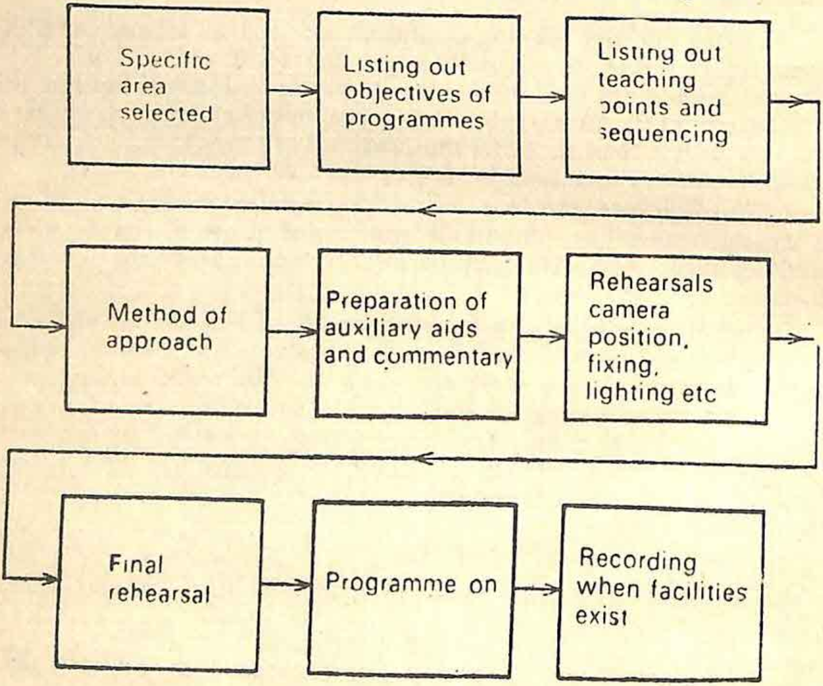
2. *TV as a Complementary Basic Resource :* In this type, T.V. acts as a basis for the total teaching process. It complements other instructional media.

3. *TV as Supplementary Enrichment :* T.V. brings the latest information to a topic of classroom discussion.

Lecture demonstrations shown by the lecturer may not be visible clearly to pupils at a distance. The small rise of liquid in the limb of a manometer, the movement of a pointer of a meter over a scale reading, the depression of the end of a cantilever with increase of load at the loaded end can be shown highly magnified on the screen. Views through microscope can also be shown on the large monitor screen. Any demonstration made by the teacher can be viewed by cameras at different positions and views selected and transmitted to one or more monitors.

Basic Procedures in Programming ETV or ITV

The various steps involved in programming and transmitting of ETV or ITV are indicated in the following flow chart diagram.


Specific area selected
Listing out objectives of programmes
Listing out teaching points and sequencing
Method of approach
Preparation of auxiliary aids and commentary
Rehearsals camera position, fixing, lighting etc
Final rehearsal
Programme on
Recording when facilities exist

Closed Circuit Television (CCTV)

In CCTV, the signal is sent to the receiver using co-axial cable. Hence the range is limited to the length of the cable. CCTV can be used to very great advantage in educational institutions. Its capabilities are as follows :

(a) Increases the range of instruction to one or more locations beyond the classroom.

(b) Magnifies exhibits and demonstrations which are normally difficult to see in a classroom situation.

(c) Provides opportunities for exchanging professors and courses between one institution and another linked to a circuit.

(d) Enables colleges to present televised instruction in accordance with their own schedules and needs.

In teacher training institutions. CCTV with video tape recorder can be used to record performance of the teacher trainees during "Micro-teaching" sessions. Video-tape provides the necessary feedback.

CCTV is used in many medical colleges in developed countries. When an operation is being performed, it is not possible and desirable to admit inside the theatre a large number of persons. But the entire operation can be covered using a single television camera or a battery of cameras located at vantage points. The signal from the proper camera can be fed to the viewer by the monitor system.

Video Tape

Storage of instruction for repetitive use is easily accomplished now with the use of video tapes. They may be played back through monitors in a studio or classroom. Video tape can provide virtually instantaneous reproduction and in that sense, it is superior to films. *Video cassettes* are also available nowadays. The user simply attaches the cassette player to his own television set, inserts a cassette and depresses a button. The obvious advantage of the cassette is that it is portable and can be used and reused at will.

Educational Values of TV

1. Communication by TV is effective because it can bring very good demonstrations and Audio-visual materials to the classroom.
2. TV can bring the world of reality to the home and to the classroom.
3. TV permits everyone to look through a microscope at the same time.
4. TV facilitates a school or college share its best teachers

rather than rationing them.

5. TV can save the time and effort of the student and teacher.
6. Concrete nature of TV makes some programmes understandable and appealing to a wide variety of age and educational levels of people.
7. TV can both be instructive and enjoyable.

Limitations of TV

1. TV is one-way communication. It does not stop to answer questions. It does not permit readily class discussion.
2. There is no personal contact with the teacher. The programmes do not adjust well to individual differences.
3. TV encourages passive form of learning rather than active seeking. It cannot provide for individual and group activities. It does not provide for laboratory experience.
4. TV screen is small in size as compared to projected pictures.
5. The equipments necessary for TV are costly and complicated. A properly designed studio with controllable lighting facilities and with acoustic proof walls is necessary. It should be maintained by competent staff all the time.

Satellite Instructional Television Experiment (SITE)

Television programmes especially prepared for rural audience began to be beamed from August 1, 1975 for the benefit of villagers in Rajsthan, Bihar, Orissa, Madhya Pradesh and Andhra Pradesh. The International Telecommunications Satellite Consortium helps the member-nations in broadening the area of operation of the television communication by means of orbiting satellites. The satellites are launched at a height of 22, 300 miles up over the equator in orbits. At that altitude they travel at the same speed as the earth's speed of rotation, i.e., 24 hours. Hence virtually they remain fixed over the same spot relative to earth. These satellites serve as TV relay stations. The instructional objectives in India are family planning.

Research programmes relating to the search of ways and means to improve the quality and effectiveness of Instructional T.V. are continually being planned and carried out. Researches regarding the "master teacher" concept has indicated that this is not as vital as it was originally thought to be and pupil learning by viewing the outstanding or master teacher on the screen was not infinitely superior to the traditional class teacher inspired learning. Perhaps this may partly be due to the apathy of the class teacher who feels displaced by the master teacher. So today instead of trying to present routine lessons on the T.V. which the class teacher may perhaps present in a better way, I.T.V. programmes tend to 'bring into the classroom learning experiences that local teacher cannot arrange.' These include costly demonstrations, complicated experiments, visual excursions to far off places and current events. Such programmes carefully produced and involving all kinds of interrelated learning experiences produce good results. In such instances also it is the class teachers involvement that ultimately determines how much pupils learn from a T.V. programme. The goals and objectives of any T.V. programme should be clear to teachers and pupils. The class teacher who accepts and uses T.V. as a good means of achieving educational goals has a greater chance of stimulating students. Such a teacher would encourage the necessary preparatory and follow up activities and induce learner involvement. In short research studies indicate that if educational T.V. is to be really effective it must become an inseparable segment of the overall classroom environment.

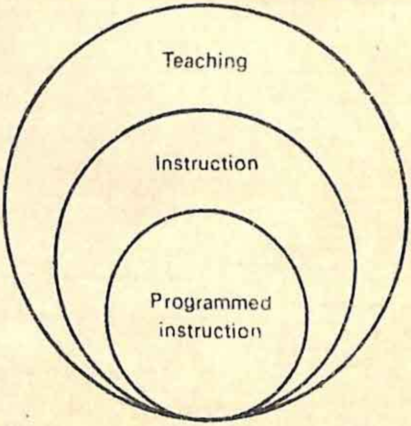
CHAPTER XII

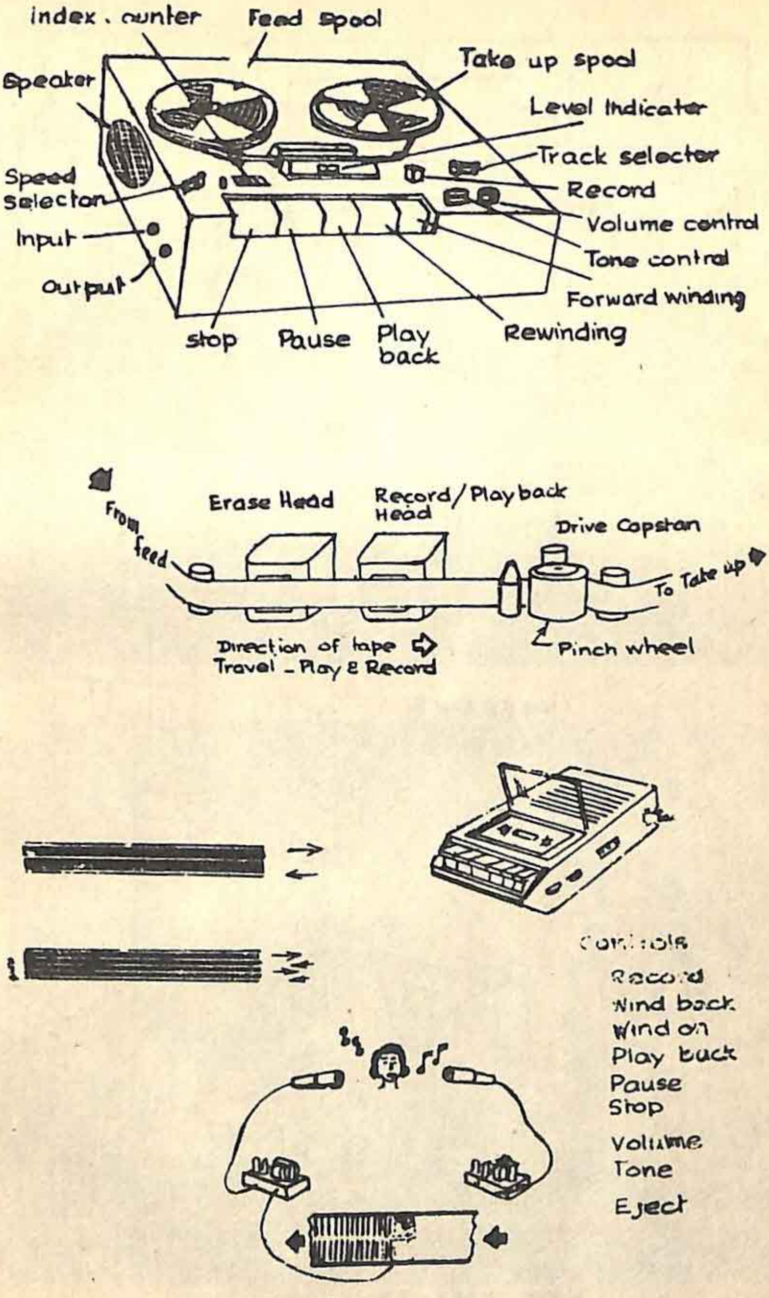
PROGRAMMED INSTRUCTION

Programmed Instruction is hardly new or revolutionary. It has some links with the ancient Greeks, 19th century Pavlov and an American psychologist Thorndike. Socrates was one of the earliest programmers who developed a programme in Geometry. This was recorded by Plato in the form of a dialogue. Socrates used to guide his followers to the acquisition of knowledge by conducting them conversationally along a path from one fact to another and insight into insight. The primary object in Socratic method was inquiry. The subject-matter was broken up into very small cumulative steps. By forcing the active participation of the pupil, continuous feedback was provided. That such a feedback and reinforcement are needed even in simple types of learning involving reflexes is seen in Pavlov's theory of conditioned reflex based on his experiments with dogs. Thorndike's major principle of learning speaks of learning as establishment of connections between situation (stimulus) and behaviour (response) and the connection is strengthened only if some success or satisfaction follows each response. (The Law of Effect)

What is "Programmed Instruction"?

Before beginning to explain Programmed Instruction, let us first see the differences between Teaching, Instruction and Programmed Instruction. According to Edgar Dale, "Teaching' is a broad, vague, ill-defined term and 'Instruction' is a purposeful, orderly, controlled sequencing of experiences to reach a specified goal." All instruction involves teaching but all teaching cannot become instruction. Programmed instruction is a sub-head under instruction and represents a more rigorous attempt to develop a mastery over specified goals to secure "insured" learning. Programmed Instruction involves controlled, carefully specified and skilfully arranged learning experiences. They are





Stereo

Fig. XI. 1
Tape Recorder

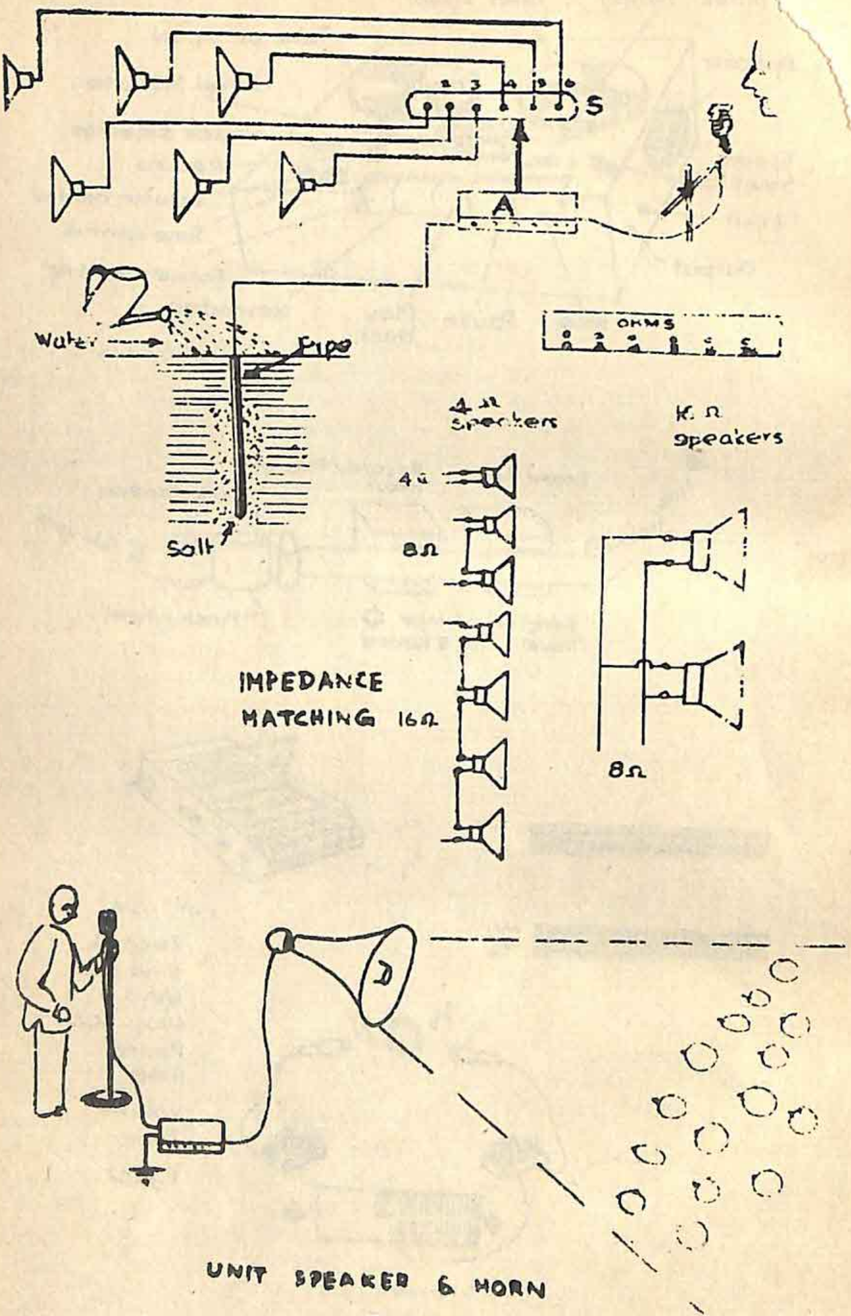


Fig. XI. 2
Central Sound System

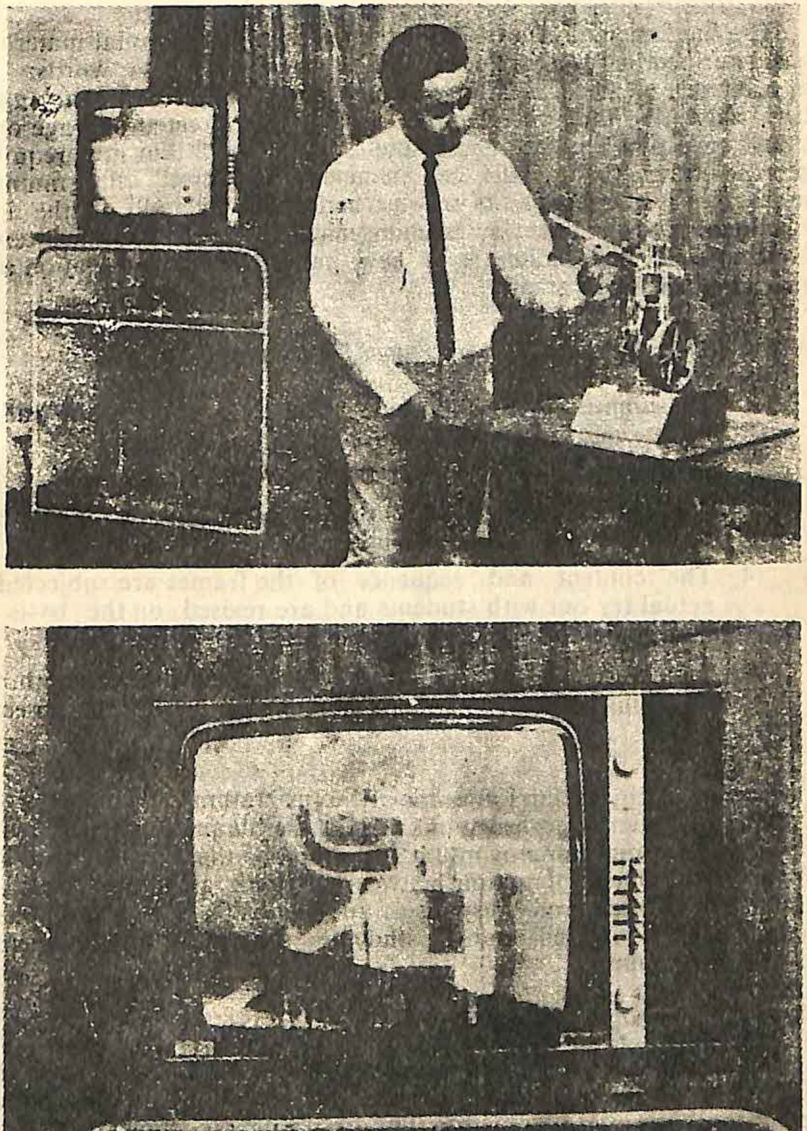


Fig. XI. 3

A—Teacher Demonstrating A Model

B—Enlarged View—T.V. Monitor

self-instructional and self-corrective.

The fundamental idea of Programmed self-instructional materials was described in 1912 by Edward L. Thorndike in these words: "If by a miracle of mechanical ingenuity, a book could be so arranged that only to him who had done what was directed on page one, would page two become visible and so on, much that now requires personal instruction could be managed by print." Programmed instruction is a technique of self-instruction in which all of the instructional load is carried by teaching machines or programmed texts. Programmed Instruction is a new path towards automation and individualised instruction.

Major Characteristics of Programmed Instruction

1. The subject-matter is broken down into small steps called *frames* and *arranged sequentially*.
2. Frequent response is required of the student.
3. There is immediate confirmation of right answers or correction of wrong answers given out by the student.
4. The content and sequence of the frames are subjected to actual try out with students and are revised on the basis of data gathered by the programmer.
5. Each student progresses at his own pace without any threat of being exposed to any humiliation in a heterogeneous class.

According to Arthur Lumsdaine, the programme tries to see to it that the student does learn and it takes the blame for the student's failure. A programme is not a text book as there is no possibility for pre-determined interaction between the book and the reader in the form of required responses and feedback. A programme is actual instruction itself and the student's success or failure depends on the programme.

Need for Programmed Instruction

The present era is passing through a period of a silent revolution in the field of education. 'Knowledge explosion' and 'population explosion' are the two factors that are trying to change the web of life. They mean large quantum of knowledge to be imparted to large population which in turn lead to a spiralling problem of opening more schools and employing more teachers. In these circumstances what is needed is an 'education explosion'. Technology or automation is the only solution to solve all these problems. Programmed instruction is an innovative step in this new direction towards automation and individualisation of instruction. Programmed learning is an application of principles of behavioural sciences and technology in the field of education. It emerged from the efforts of American psychologists during the present century. Significant contributions have been made to the theory of programming by Sidney L. Pressey, Robert M. Gagne, Robert Mager and B.F. Skinner.

Contributions of Pressey

Sidney L. Pressey, a psychologist of Ohio State University, is credited for developing in 1920, a self-teaching machine called 'Drum Tutor' which could teach as well as test. The machine presented a series of questions to the student until the student responded correctly. When the particular criterion was reached, the item was skipped. When the question was set, the student selected his response from the multiple choice alternatives by pressing one of the keys corresponding to the answer. When all the items in the lesson were learned, the machine stopped and hundred per cent mastery of the lesson was taken for granted. Pressey's type of machine was a testing machine and not a teaching machine. This adjunct auto-instructional programming had the advantages of fitting conveniently with all the instructional materials. After teaching the subject-matter in any one of the conventional methods, this self-testing machine can be effectively used as a diagnostic tester.

Pressey called the period as the coming of "industrial revolution" in education. In the era of economic depression marked by rising unemployment, Pressey talked of saving material and labour and hence his remarks were not well-received by educators. Pressey received recognition he sought for his work only in 1950.

Robert Mager

Mager gave a new concept known as "Learner Controlled Instruction" which is a kind of Socratic dialogue in reverse, where the learner led the instructor. The main theme of the learner controlled instruction is that the learner is one of the best sources of information about himself. The task of the instructor is responsive rather than directive. The instructor remains silent until the learner stimulates him with questions that suggest the needed illustrations, demonstrations or some other help.

Mager conducted studies to find out whether the learner-generated sequence was more efficient than the instructor-generated sequence. It was concluded that learner-controlled instruction was very effective. The programmer develops a unique programme for each learner. It is wrong to claim that learner-controlled instruction is a panacea; it simply reminds that the learner deserves consideration. The attempt to impose order on learning is futile. In programming sequence, the observation of learner's behaviour should begin early, followed by the determination of objectives before proceeding to write the frames. Mager's studies also emphasise that the experience of the learner can possibly be used as basis for further understanding.

Mager is also remembered for his stress on the formulation of instructional objectives in a clear and specific manner before proceeding to organise instruction. Such objectives are at the bottom of programming too. Mager states, "once an instructor decides he will teach his students something, several kinds of activity are necessary on his part if he is to succeed. The first among these is to decide upon the goals he intends to reach at the end of his course or programme. All other activities stem from the selection of objectives and goals. A statement of instructional objectives is a collection of words describing one of our educational intents." The objective clearly specifies the terminal behaviour of the learner at the end of instruction. Description of such a terminal behaviour will include identifying and naming the overall behaviour act, defining the important conditions under which the behaviour is to occur and defining the criterion of acceptable performance. Though some educationists have criticised the spelling out of such specific behavioural objectives of instruction, research conclusions say that such objectives are useful and almost never harmful. They give direction to teaching and help in curriculum development and also provide guidance for evaluation. Specifying objectives is the first step in evolving programmes of instruction.

Robert M. Gagne's Theories

Gagne, Benjamin S. Bloom and Robert F. Mager are three psychologists who have explored ways to make learning more systematic and efficient. Gagne has drawn our attention to hierarchy in learning starting from the simplest level of signal learning and ending with the apex of problem solving with S-R learning, chaining, verbal association, discrimination learning, concept learning and rule learning coming in between in that order. Bloom's Taxonomy is a more comprehensive classification of all the goals of instruction.

Gagne's main concern was with task analysis, the proper sequencing of tasks and the transfer of effects involved in learning a series of tasks. Sequencing is the careful ordering of each part of an auto-instructional programme so that each frame and the elements within it enable the student to use what precedes and succeeds it.

Gagne defined knowledge as the ability to perform "a class of specific tasks." The learning behaviour can be analysed into a series of learning tasks. Gagne says, "the learning task is the smallest part of a total operation which would be assigned to a man to complete as a step in that operation". He also defines it as "the smallest unit of performance which can be identified as having a distinct and independent purpose."

Programmed instruction is concerned with the need to define terminal objectives in specific behavioural terms. The intermediate or component tasks that must be achieved before the terminal task must be specified. The proper sequencing of these component tasks was one of Gagne's major concerns. The knowledge hierarchy is primarily a hierarchy of learner capabilities. These capabilities help the learner in performing the sub-tasks and thereby move to knowledge hierarchy. This is achieved by carefully structured small steps.

Instructional Objectives and Specification of Behaviour

As stated earlier, one of the outstanding contributions that programmed instruction has made to educational practice is its emphasis on the importance of specifying educational objectives in terms of specific behaviours. Behaviour is any visible activity displayed by the learner and hence can be observed and measured. The conventional objectives are very broad, covering many points without making them explicit. They describe various aspects of the process or a course. But the objectives must be stated in meaningful terms in the form of observable and measurable behaviours. Instead of stating the objectives as 'knowledge' or 'understanding', it must clearly be stated using action verbs such as 'to write', 'recite', 'identify', 'solve' 'construct', list, label, etc. Meaningful objectives describe the product, depicting what the learner will be as a result of the process.

The programmer must first state the general objectives of a unit of instruction and then describe the specific objectives desired in the course which are called the 'Terminal behaviours'. Peter Pipe suggests that the programme must build a pyramid of objectives. A thorough analysis of the integrated hierarchy of behaviours called 'component behaviours' which will gradually enable acquiring the specified terminal behaviours must be developed. The end-product depends upon the input that is present at the beginning of instructional process. Previous knowledge or entering behaviour is the beginning line from which the terminal behaviour or the end-product is shaped. Entering behaviour suggests where the student is and terminal behaviour suggests where he will be at the end of the instructional process. The information regarding entering behaviour may include previous experience, aptitude, age, interests, ability, and a level of attainment in particular subject of the pupils for whom the programme is planned.

Instructional goal or Generalised goal
↓
Programme Objectives (Terminal Behaviour)
↓
Component Behaviours (Interim Behaviours or Enabling Behaviours)
↓
Probable pre-requisite skills (Entering Behaviour)

Task Analysis: Task analysis includes analysis of terminal behaviour and also analysis of all the activities that the learner has to do during the instructional process. It should also identify and describe the sequence of activities taking into account the concepts and skills involved in them. Task analysis describes the pupil's en route behaviour, i.e., any activity that the student must master as a preliminary or basic skill to enable him to perform the terminal behaviour.

Criterion Test: Entering behaviour indicates the minimum competence which makes the student eligible to take a programme. Terminal behaviour indicates his changed or modified behaviour as a result of the programmed material. The test to assess whether the behaviour has been modified in the desired or expected direction is known as 'criterion test.'

In a successful programme, every learner should score 100% on criterion test. If the criterion test is given at the beginning of the programme, the learner will score only zero per cent. Criterion test is not concerned with easy or difficult questions. Students are also not graded on the basis of the performance in the criterion test as cent per cent achievement is the goal in achievement level.

Criterion test can be prepared even at the time of preparing the programme. It provides the necessary feedback to the instructor for sharpening the objectives. The programmer should get the whole structure of criterion test reviewed by an expert in the subject-matter as well as in the technique of testing. According to Peter Pipe, the following are some of the characteristics of a criterion test:

(a) A criterion test tests almost all teaching points;

(b) It does not include the same examples and situations given in a programme;

(c) The type of questions are not the same as in the programme material;

(d) The items in the criterion test need not be in the same order as they occur in the programme.

(e) The difficulty value of the criterion test depends on the instructor's goal regarding the level he wants the learners to attain.

The test should be administered to a representative group of students and the discriminative power of each test item should be analysed. The test items may have to be modified on the basis of this analysis.

B.F. Skinner's Theory of Operant Conditioning

B.F. Skinner, the famous psychologist of the Harvard University formulated his theory of behaviour based on conditioning and created a revolution in the field of learning. His approach is called 'Behavioural engineering' because Skinner is more interested in determining how to control behaviour than in devising theoretical explanations of the processes that underlie behaviour. The two experimental techniques that are used to manipulate the environment in well-defined ways are the Pavlovian 'classical conditioning' and the Skinner's 'operant conditioning'.

In classical conditioning, a reflex which is an involuntary response that is elicited by some specific stimulus is paired with an arbitrary or conditioned stimulus so that later the conditional stimulus elicits the reflex response. Most S-R theorists believed that in the absence of any external stimuli, some internal stimuli must evoke the response. Pavlov's experiments proved that the conditioned reflex continued to occur only if the conditioned stimulus was at least occasionally presented in conjunction with the unconditioned stimulus. If it was not, the conditioned reflex gradually disappeared. This is called extinction. Since respondent behaviour is concerned with stimulus, it is known as *S-type conditioning*.

Skinner was against this "No stimulus-no response" theory. He believed that most of the responses could not be attributed to known stimuli. He attached great importance to *operant behaviour* which is primarily concerned with responses rather than stimuli. It is known as *R-type conditioning*. Out of many responses, which an organism is capable of giving, the problem of the experimenter is to select the appropriate responses and fix them properly. Thus Skinner changed the usual S-R formula into R-S formula. In behaviourist terms, the reflex response in classical conditioning is elicited from the organism by the stimulus. Operant conditioning on the other hand is said to be *emitted* by the organism without any provocation of an identifiable stimulus. The behaviour of a rat in a cage, the flying of a bird, the babbling of babies are natural and are not normally elicited by any external stimuli. These are examples of operant behaviour. The occurrence of operant behaviour can, however, be influenced by events in the environment, in particular by rewards and punishments. Generally appearance of an operant behaviour that is followed by desirable consequences will be repeated and that which is not followed will not be repeated often.

The basic principle of Skinnerian conditioning is that behaviour that is rewarded, tends to be repeated. The rewards (like food, a drink of water, etc.) for the appropriate behaviour are called reinforcers. A reinforcer is any stimulus that increases the probability of the response. The consequences of reinforcing an operant activity is an increase in its rate or probability of occurrence per unit of time. Reinforcers, according to Skinner are of two kinds. Positive reinforcers are stimuli, which when applied following an operant response, strengthens the probability of that response (a pellet of food for a hungry pigeon, a piece of candy to a well behaved child). Negative reinforcers are stimuli which when removed following an operant response strengthens the probability of the response (loud noise which stops when a bar is pressed or electric shock which ceases when a bar is pressed). Punishment is different from negative reinforcement. Punishment is a penalty which a subject faces for performing a wrong or disapproved act or for failing to perform an approved act. But negative reinforcer is removal of punishment resulting in an increasing frequency of previously practised response. Skinner's animal experiments have also illustrated the *shaping of behaviours*. In shaping the experimenter reinforces only those responses that are in the desired direction. Shaping involves successive approximation to what is desired behaviour. Further experiments on schedules of reinforcement reveal that reinforcements occurring only some of the time establishes a response rate that is more stable than cent per cent reinforcement.

Skinner's Experiments on Operant Conditioning : Three pieces of study conditioning of operant behaviour viz., Skinner Box, Maze and Jumping stand.

Skinner Box: Essential parts of Skinner box are a bar, a light or buzzer and a food cup. The light or buzzer is used in the establishment of precise stimulus control. The experiment consists of placing a rat inside the box and training it to press a bar for a food reward in much the same way as a person pulls a lever to obtain a food from a vending machine. An untrained rat has in its behavioural repertoire all the operant behaviours necessary for bar pressing but they rarely occur in the proper sequence. The purpose of this experiment is to shape the animal's behaviour into a desired response by proper reinforcement. During shaping, the experimenter closely watches the behaviour of the animal and rewards the animal only when it exhibits a new behaviour that is closest to the desired response. The sight of the food and the 'click' sounds of the buzzer that accompany the delivery of the food become signals for the reinforcer.

Maze: The hungry or thirsty rat runs along the paths that lead to the goal—box containing food or water which serves to reinforce movement along the correct path. The human experimenter does not affect the rat's learning in a maze because the maze itself shapes the behaviour. The rat will not find the food unless it moves along the correct path.

Jump Stand: This apparatus devised by Lashley, is used to train a rat to jump through a door that is marked with a particular stimulus pattern. In this device, both punishment and reinforcement are used and hence learning is much faster than in the other two devices, namely · Skinner Box and Maze. Both doors are placed adjacent to each other but one door may have a particular type of stimulus. If the rat jumps through the right door, it may find its food and if it attempts to jump through the wrong door which is locked it bumps its nose and falls into a net.

Experiments for Discrimination, Training and Generalisation

If a pigeon has been reinforced to peck yellow light, it will also peck at light of all colours. This is called *stimulus generalisation*. If the experimenter gives reinforcement to the bird only when it pecks at the yellow light, the pigeon will stop pecking at other lights. This is called *discrimination training*. Discrimination training sharpens and strengthens stimulus control by establishing a discrimination stimulus.

Application of Operant Conditioning in Learning: Skinner is convinced that operant conditioning so fruitful when applied to animal learning, promises equal success when used in schools. Even a creature like a rat can be led to a desired behaviour by means of carefully constructed programme consisting of small steps leading logically, provided each step is reinforced. Hence the basic assumptions of learning is that behaviour is learnt only when it is emitted and reinforced. Skinner was highly critical of the current educational practice which he called as inefficient and harmful; a neglected method. The teacher instead of teaching, simply holds the pupil responsible for learning. Examinations are designed to show what pupils do not know. Educational control is aversive, emphasising criticism, ridicule and punishment. There is too much lapse of time between act and reinforcement as also relative infrequency of reinforcement. There is lack of a well organised presentation of stages in teaching skills. Skinner emphasised that learning of pupils should be shaped by a series of reinforcements. According to him the two basic considerations of programmed learning are the gradual elaboration of extremely complex patterns of behaviour and the maintenance of the behaviour in strength at each stage. The whole process of becoming competent in any field must be divided into a very large number of small steps and reinforcement must be contingent upon the accomplishment of each step. By making each successive step as small as possible, the frequency of reinforcement can be raised to a maximum, while the possibly aversive consequences of being wrong are reduced to a minimum.

Computerised systems of instruction which has now come into vogue are also based on Skinner's operant conditioning principle. Such instructional systems include the computer managed instruction (C.M.I.) in which the computer stores information about students, teaching materials, test scores, etc., and after analysing the relationships of these various factors suggests activities appropriate for individual students. Such systems as PLAN (Programme for Learning in Accordance with Needs) developed by J.C. Flannagan in 1968 and the IPI (Individually Presented Instruction) developed by W.W. Cooley and R. Glaser in 1969 are of this type. The CAI (Computer Assisted Instruction) in which the computer functions essentially as a tutor as well as the Talking Typewriter developed by O.K. Moore in 1966 are based on Skinnerian principles of learning.

The following operant conditioning principles are also involved in the learning process:

- gradual progression to establish complex repertoires.
- gradual withdrawal of stimulus support.
- controlling learner's observing.
- discrimination training.

On the basis of these, Holland suggests eight basic principles for developing a programme.

1. Each response must be reinforced immediately.
2. Only overt responses are suitably reinforced.
3. Errors have an adverse effect on learning.
4. Progress must take place in small successive steps.
5. Prompts to the learner should be withdrawn gradually.
6. Student's observing behaviour should be controlled.
7. Extensive discrimination training is needed to establish abstractions and concepts.
8. The learner should help to develop the programme.

Basic Ideas in Programming

Programme is usually presented by a book or machine. Teaching machines present programmed material to pupils in such a way that one problem depends upon the answer to the preceding problem and where, therefore, the most efficient progress to an eventually complex repertoire can be made. The mere manipulation of the teaching machines is reinforcing and can keep the pupil working for a long time. Teaching machines may be mechanically or electrically operated. Normally, however, it is in written form. Material is broken into smaller units called 'frames'. Frames are arranged in proper sequence. In each frame, information is presented and question is asked. Immediate feedback is given to the learner by stating whether the response is appropriate or not. Programme allows the student to work individually and to adjust his rate of learning to his abilities, needs and conveniences. There is always active learning. Programmed materials are based on definitely planned criteria of entering behaviour and terminal behaviour. They undergo extensive try-outs with individuals and groups before being adopted in final form.

There are three types of programming—Linear, Branching and Mathetical.

Linear Programme: Skinner and his associates are the originators of the Linear type of programme. It is based on the principles that Skinner formulated in the course of his experiments with animals referred to earlier. Questions are asked directly and the student is asked to think and write down his answer. Such an answer is referred to as a 'constructed response'. A linear programme is called a straight line programme as the learner starts from his initial behaviour to the terminal behaviour following a straight line. The student proceeds from one frame to the next until he completes the programme. Subject-matter is broken down into very small steps and each step is presented in proper sequence. The responses of the student are immediately reinforced in the succeeding frames. In each frame, a small amount of information will be presented; the student will be required to make an active response; positive reinforcement or feedback is given and prompts or cues are provided that enhance the probability of correct responses and eliminate or greatly diminish errors. The format of the linear programme is as follows:

Frame Number One

1. *Stimuli*
    a. bit of information
    b. question based on the information
2. *Response*
    space for response—a blank in a sentence or after question
3. *Cues*
    (may be present or absent)

Frame Number Two

1. Correct answer to frame no. 1
2. Information
3. Stimulus
4. Response
5. Cues

Frame Number Three

1. Correct answer to frame no. 2
2. Information
3. Stimulus
4. Response
5. Cues

Chief Features of Linear Programme

1. Every learner follows the same path.
2. Programme is composed of small steps. Each frame is small and carries a single idea, example or rule.
3. Only one response is required.
4. Prompts or cues are given in the earlier frames to minimise probability error and are generally withdrawn towards the end.
5. Every student works at his own speed and follows the frame in the same order. Applying the principle of branching, we get another hybrid programme called *skip linear programme*. In this type, the learner is given test questions at certain points. If correct responses are given by the student, the learner can skip over some part of the information and can go to another part of the programme.
6. Feedback or reinforcement is quick. Immediate knowledge of results acts as a reinforcement and maintains motivation.
7. Cheating is discouraged by not revealing the response until the learner has registered his response.
8. Response asked for requires a critical observation and comprehension of the frame.

Example for Linear Programme

Frame 1

When a man pulls an object, he is said to be working. Work is therefore accomplished when an———— is moved.

(*object*)

Frame 2

When an object is hard to move, it is said to offer resistance. A heavy object will offer more———— than a light object.

(*resistance*)

Frame 3

This————to movement is called as opposing force.

(*resistance*)

Frame 4

A heavy object will offer more————force than a light object.

(*opposing*)

Frame 5

When a man moves an object, he is working against an———.

(*opposing force*)

Frame 6

It requires work to change the position of an————against an opposing force.

(*object*)

Frame 7

To overcome an opposing force, the man must use force. He uses more———— to move a heavy object than a light object.

(*force*)

Frame 8

The man must————harder when the opposing force is greater.

(*work*)

Frame 9

When a given object is moved a long distance, it offers resistance all the time during the movement. It therefore takes———— force to move an object a long distance than a short distance.

(*more*)

Frame 10

The further an object is moved, the more————is required to do so.

and so on. (*force*)

When to use the Linear Programme ?

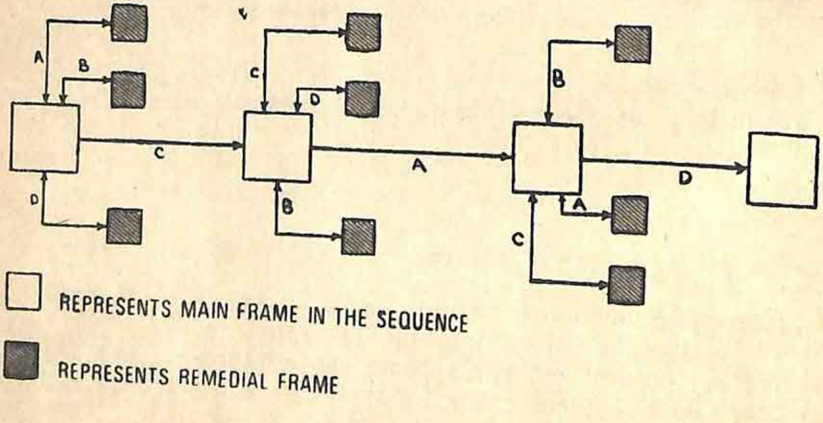
Linear programming is based on the assumption that we can carefully analyse the steps in learning and present them in the right sequence at the right time with appropriate reinforcement. Emphasis is placed on the correct response of the student and cent per cent achievement is assumed. If the child does not learn, any one of the steps is wrong. The following are the occasions when linear programme may be used.

- —when the programmer thinks that the learner cannot digest a large chunk of material,
- —when the programmer thinks that the concepts or skills are important to be completely mastered,
- —when the learners have more or less the same entering behaviour,
- —when it is provided empirically, that the very nature of the content demands linear format.

Branching Programme

The Branching technique was developed by Norman A. Crowder (1960) and is called 'Intrinsic programme'. In this type each frame is of relatively bigger size and may contain two or three ideas of related sequence. A single question, usually of the multiple choice type is asked at the end. The student selects the response. If the student chooses correctly, he is taken to the next frame in the main teaching sequence. If his response is wrong, he is taken to a remedial frame where his mistake is explained and the topic under consideration is further explained, perhaps using some more examples. After remedial work, he is directed to the original frame for making another attempt at choosing the right answer. According to the alternatives selected, the learner will be directed to go to a particular page. Branching programme anticipates the errors of learners. The errors are diagnosed and remedial instruction is provided. Hence in a programme of this type, all learners do not follow the same path and they branch. Crowder points out that branching programme is like a human tutor and 'talks back' to the student.

Diagrammatically, a sequence from a programme of this kind might be represented as follows :


A
B
C
D
C
D
A
B
B
D
A
C
☐ REPRESENTS MAIN FRAME IN THE SEQUENCE
▨ REPRESENTS REMEDIAL FRAME

In this example four alternative answers A, B, C, D are given.

Schematic Representation : The one that is explained above is a simple form of branching where the student is never taken to more than one frame from the main sequence. In complex branch programming, a student may be asked yet another multiple choice question in the first remedial frame and lead on to remedial frames more than one step away from the main sequence frame. The contents of a content frame and remedial frame can be given as follows :

Content frame

(a) Repeating student response,
(b) Positive confirmation,
(c) New information,
(d) Question,
(e) Alternative answers followed by directions to the learner to go to relevant page.

Remedial Frame

(a) Repeating the student response,
(b) Negative confirmation,
(c) Reasons as to why he is wrong,
(d) Further explanations in simple language,
(e) Directions as to where the learner should go next.

When the frames of a branching programme are presented in a book form, the book is called *scrambled book*. In this book, the correct frames are not arranged in normal sequence. The alternative frames subsequent to a given frame are put on widely dispersed pages throughout the book. The pages in such a book cannot be read consecutively but only in response to the choice of the learner's answer.

An Example for Branching Programme in Simple Arithmetic

Page 1

In a multiplication the two numbers that are multiplied together may be called the 'factors' and the result is called the product. Thus in 2 × 3 = 6, the numbers 2 and 3 are called factors and the number 6 is called the product.

Below you will find a question. Pick what you think as

Page 3

Your answer on page 1 was 6.

You seem to have merely used 2 & 3 as factors in a multiplication. The problem was to use the number 3 as a factor twice. In other words, we want the result of the multiplication $3 \times 3 = ?$ Now return to page 1 and try again.

the right answer to the question and go to the page number given against the answer.

The question is : What is the result (product) if 3 is used as a factor twice in a multiplication?

Answer : 6—Turn to page 3

Answer : 9—Turn to page 5

If you do not understand. turn to page 7

Page 5

Your answer on page 1 was 9. You are correct. If we use 3 as a factor twice, in a multiplication, we get $3 \times 3 = 9$ as result.

Now, what result would we get if we used the number 2 as a factor three times.

Answer 6 — (Turn to page 4)

Answer 8 — (Turn to page 10)

Answer 9 — (Turn to page 13)

Page 7

Your answer on page 1 was "I don't understand". We are asking you what product you get from a multiplication in which you use the number 3 as a factor twice; in other words what is the result of the multiplication in which the numbers that are multiplied together are both 3's? i.e., what is the product of 3×3 ?

Now return to page 1 and choose the right answer, and so on.

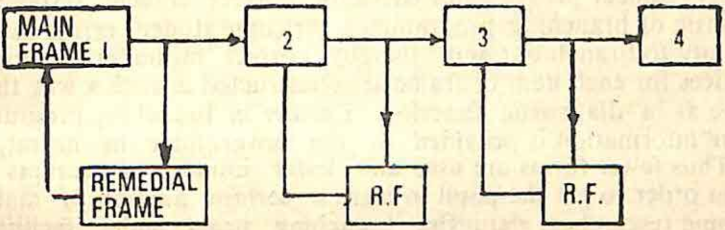
Advantages in Branching Programme

1. The bigness of the size of frame as well as branching reduces unnecessary repetitions and responding. This saves the amount of the learning time and reduces fatigue.
2. Remedial frames not only explain the subject matter further, but also reasons out why some other response is not correct.
3. When a programmer knows that the learner's entering behaviour differs from each other, branching programme is more suitable.

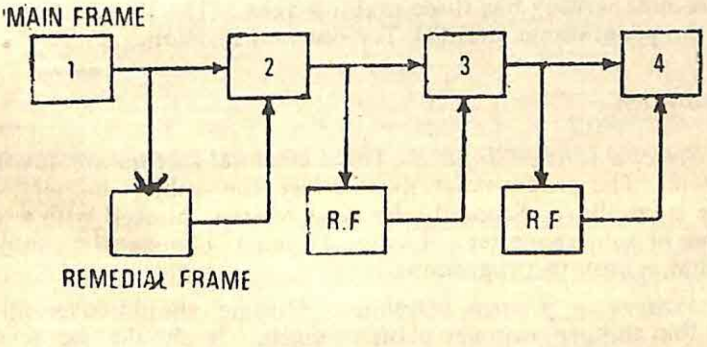
Techniques in Branch Programme

There are two techniques in which branch programme can be arranged. They are called *Backward Branching* and *Forward Branching*.

Backward Branching : The learner goes from first frame to second frame only if he makes correct response. If he makes an error, he is led to a remedial frame where he is given some more help in understanding the concept and in solving the solution by a better logic. He will then be directed to the original frame number one. He reads again, answers correctly in the light of remedial material received earlier. So the learner goes through the same frame twice, once before the remedial material and secondly after the remedial material.



Forward Branching : In this type, whether the learner is making correct response or wrong response, he will always be going to new pages, progressing from page to page. When he makes a wrong choice, he is directed to a remedial frame where his mistakes are fully explained, probably followed by another parallel question, from which he goes to the next frame in the main stream. Diagrammatically, it can be represented as follows :



Each technique has its own merits. Although the Forward branching gives an advantage of apparent progress, Backward branching definitely motivates the student to see what he missed in the first attempt.

Klausmeir has clearly pointed out how branching programmes differ from linear programmes. In branching programmes small steps are not used. The student selects a choice from among those given rather than constructing a response. Subsequent steps or branches that are to be taken depend on which choice the student has made. Linear programmes strive for correct student response, but intrinsic or branching programmes welcome student errors as an opportunity to branch out and thereby correct misunderstandings. The choices for each item or frame are constructed in such a way that they serve as a diagnostic function. Further in branching programmes more information is provided in the programme in narrative form. Thus fewer forms are used and lesser number of prompts is needed in order to get the pupil to learn a certain amount of material. Some researchers claim that branching programmes facilitate learning to a greater extent than linear ones. But others suggest that there are advantages to each type of programming. However, the linear programme is easier to write and there is greater chance of teachers attempting to write out this type of programme.

Dynamics of a Programme Development

The process of developing a programme is highly dynamic, challenging and time consuming exercise. In writing a programme, the programmer must be skilful and pragmatic. The content structure must be closely linked with the terminal behaviour.

Programme writing has three major stages : (1) Preparation, (2) Writing the programme, and (3) Try out and revision.

1. *Preparation*

(a) *Select a Unit or Topic :* Three essential factors are involved in this step. The programmer must select the subject-matter with which he is familiar. Secondly, he must restrict himself with a very small area of subject-matter. Lastly, he must choose the subject-matter that is easy to programme.

(b) *Prepare a Content Outline* : Outline should cover all the material that the programmer plans to teach. It should be a product of careful examination of textbooks and reference sources. If the programmer has not taught the subject, he can consult an experienced teacher who can supply knowledge, specific examples and interesting illustrations.

(c) *Define Your Objectives in Behavioural Terms :* The writing of objectives involves both task description and task analysis. Task description is the description of terminal behaviours. Task analysis is the examination of component behaviours or enabling behaviours which the student must acquire in the process of reaching terminal behaviour. The pyramid of objectives that the programmer builds are the links in the chain between the entering and terminal behaviour.

(d) *Construct a Test of Entering Behaviour* : The prerequisite behaviours are the bases for writing the items for the test of entering behaviour. This will help the programmer to know the point at which he must begin his programming. If the group is heterogeneous, there must be considerable variety in entering behaviour. A branching programme can be of great help if the children vary in their entering behaviours. Those with large number of entering behaviours can skip through the initial frames.

(e) *Construct a Test of Terminal Behaviour :* At least four test items must be prepared for each terminal behaviour. These should be scrambled and should not follow an order in which the terminal behaviours were acquired. Peter Pipe suggests that the terminal behaviour test may be administered to the students before they study the programme. Materials which the student already knows must be deleted from the programme. Students must secure zero score on the terminal behaviour test if it is administered before the programme.

2. *Writing the Programme*

With the content outline and pyramid of behavioural objectives, the instructional events must be planned.

(a) *Present the Material in Frames* : A frame is a small segment of subject-matter which calls for particular student responses. Care must be taken to see that proper sequence is followed. Student must be led gradually from simple to that which is more complicated. No more than one concept or fact to be learned is introduced at a time. New stimulus material is gradually introduced and the cueing with familiar material is gradually withdrawn.

(b) *Provide for Active Student Response* : The student is asked to make the response in every frame. A blank should appear as close to the end of the frame as possible. Although responses can be made either overtly or covertly, research has proved that overt responding group perform significantly better on the post test than the covert responding group.

(c) *Provide for Confirmation or Correction of Student Response :* Correct response must always be provided so that the student can compare his own response with it. This is the most distinguishing characteristic of the programmed instruction. Krumboltz and Weisman (1962) suggest that supplying the correct response may be more important later than in the earlier frames, when most of the prompts for the correct responses are withdrawn.

(d) *Use Prompts to Guide Student Responses*: Prompts are cues provided on the programme frame to guide the student for making correct response. Research has proved that 'instructional procedures which furnish the student sufficient guidance to avoid mistakes is superior to procedures which only correct errors after they are made'. Prompts have two purposes. They guide the student to the correct response and they prevent the student from making unnecessary errors. Prompts may be withdrawn in the later stages so that the students emit the terminal behaviour without supporting cues. The gradual removal of the prompts is called 'vanishing' or 'fading'.

(e) *Provide Careful Sequencing of Frames*: The sequencing of the frames depends upon the description and analysis of the behaviours that the programme intends to teach. All the basic learning conditions like discrimination, generalisation, contiguity, practice and reinforcement can be embodied in the frame sequences.

3. *Try-out and Revision*

Programme must be read at least by one subject-matter expert to check for inaccuracies in the content. After editing the draft, the programme must be tested on a small group for validation. Responses are studied in detail and all the difficulties met with by the learners are noted. If it is a linear programme, attention must be paid to the error rate. Conventional standard has been 10 per cent error rate. For branching type, the error rate for frames with questions should be higher. If it is not, it implies, that many branches are being wasted. Linear frames with high error rates and branching frames with lower error rates are then rewritten. The programme is then tested on large sample. Attention is directed to the gain in the achievement which can be measured as the difference between the pretest and post-test scores. If these are inadequate, the programme must be rewritten. Hence the cycle of programme writing is testing, writing, testing, which is repeated until the programme is demonstrably brought upto the standard.

Mathetics

Linear and branching programmes are the conventional models in programming. Mathetics is the newest and most controversial approach to programmed instruction. Mathetics comes from the

Greek root *Mathein* which means 'to learn'. Thomas F. Gilbert is the originator of the concept of mathetics and he described the systematic procedures of mathetics in 1962. In mathetics style, an 'exercise' is the technical unit of learning instead of a frame as in the linear type.

As a technique of teaching, Mathetics can be applied to a wide range of subject-matter but it is specially suited to teaching of skills. It is a complete training system that guides the trainer to discover the training deficiencies of specific population. The system includes guidelines for analysis of skills, knowledge to be learned and specific strategies to overcome the deficiencies.

In a task completion, motivation is the most important factor. Mathetics utilises this principle to a great extent. Naturally the last task or the completion of the task brings motivation. Hence mathetical programme that utilises this principle starts from the last task or frame in the series and retrogresses. Having completed the last task first, the learner goes to the next one before it in the next frame and thus to the introductory part. So the tasks or frames have to be properly connected from the last to the first. Otherwise the frames will lose relevance, sequence and logic. This procedure is called 'chaining'. Retrogressing chaining technique is the characteristic of the mathetical style of programming. Chaining has become synonymous with Mathetics which is not correct. Chaining is the process of binding the tasks or frames from the last to the first but the model is mathetical programme.

Basic Steps in Mathetical Programmes

1. Data collection and task analysis.
2. Prescription for mastery—characteristics of the trainees are assessed.
3. Characterisation and lesson plan—deficiency is listed out and plan is prepared to overcome the deficiency,
4. Exercise writing—prescription
5. Editing.

Mathetics is more suited to teaching of skills. It is considered as a complete training system that gives the programmer (a) a guide for determining what to teach, (b) a basis for making teaching strategy decisions, and (c) a detailed procedure for construction of a programme.

Mathetics can be described as clinical in its purpose. It analyses the deficiency and tries to make it up. Mathetics is elective in nature but is unique in application, if not in principles. All inclusively mathetics is a step towards technology of education.

Adjunct Programmed Material

A practical approach to programming especially for the individual teacher, is to use the available material as such as a well written test This is then supplemented with a prepared question and answer sheet and with other materials needed. This approach has real advantages;

1. The test material may be used for programmed learning and also for review and reference. Adjunct programmes have a distinct advantage over programmed materials which are self contained. Self contained programmed materials are generally unsatisfactory for obtaining an overall view of content. Adjunct programmed materials, however, do allow an overall view of the content for review and serve as a ready source of specific information.
2. An adjunct programme is relatively easy to prepare and modify.
3. The student has all the advantages of the textbook including the table or contents and an index. He can go back into the text for review and to locate specific information at any time.
4. The rapid and experienced learner is not held back by the necessity to read and respond to a large number of small items as found in linear programmes.

Advantages of Programmed Instruction

1. The student is continually active when he is using a programme. In other methods of teaching, he is active only sometimes and practically nil in a lecture.
2. Programmed instruction is basically individual instruction. Every student proceeds at his own pace. In a conventional class, the teacher attends to only children of average abilities with the consequence the intelligent get bored and the dull have no extra help. But programmed instruction helps the dull with extra information where it is needed and no stigma is attached to the making of mistakes. At the same time, it does not hold up the progress of a fast learner as he goes along and completes the task at his own pace of learning.
3. Immediate reinforcement helps a child to know whether his answer is right or wrong. In normal class feedback takes a long time.
4. A programme is planned and prepared much more carefully than a teacher would do for a conventional teaching

programme. Mostly programmes are written by experts in the field.

5. Each programme has to prove itself to be effective during the process of validation and must be rewritten as many times as is necessary. If proper learning does not take place, it is only due to the fault of the programme and not of the learner. This positive attitude is quite distinct from what we normally witness in normal class situations where there is always the tendency to blame the pupils rather than the teacher when there are failures in examinations.
6. A programme is not a human being and hence can be used at any time of the day. Programmed materials or teaching machines are never tried and never lose their temper or patience. Hence programmed materials are very useful in the field of non-formal education.

Limitations of Programmed Instruction

The following are the limitations of programmed instruction:

1. Programmed learning does not eliminate competition or grades as often claimed.
2. Mere manipulation of a machine is not rewarding to children as Skinner seems to think. Once the novelty was off and if at the start, too many errors appear the pupil loses interest and motivation. Later reinforcements often do not accelerate learning.
3. Programmed instruction restricts the learners' freedom of choice resulting in cramping of his imagination and initiative.
4. Operant conditioning is found successful only with some pupils, in some cases and not in all. Programmed instruction ignores or makes inadequate provisions for variables like cognitive variables, personality variables and motivational variables.
5. The teacher-pupil contact which is so vital for development of human personality and relationship is completely lost.
6. In language learning, speech is equally important as development of reading and comprehension skills. But there is no scope for providing this experience.

Misuse of Programmed Instruction

Like any other approach to teaching, Programmed Instruction can be misused. Good programmes may be used in situations which are not consistent with the content of the programme. Exaggerated claims have been made for programmes. The tendency to measure the effectiveness of instruction solely by written tests is also responsible for some confusion. The fact that one approach as compared with another produces higher or lower scores in examination does not provide proof that one method is superior to another. Written tests are at best rarely capable of measuring all of the desired outcomes of instruction.

Programmed Instruction and Teacher

Programmed learning has shown a new path towards automation and individualisation of instruction. When programmes are fed into a machine, it is called a 'teaching machine.' The effectiveness of teaching machines or programmed materials is well known. Programmes can present stimuli and reinforce correct responses more promptly and dependably than can a human teacher. Machines make fewer mistakes. They never scold. They never get tired. They have infinite patience. The very impersonal nature of the machine helps emphasise the subject matter. They largely solve the problem of individual differences. Teaching machines and programmed instruction are in their infancy but yet have come to stay. Several programmes have already been prepared and tested for their efficiency.

With the advent of this technology in the field of education, teachers may sometimes fear that their jobs will be taken over by machines. All the miracles of medicine of recent origin have not put any physician out of work. Similarly new machines are only improved tools and can never replace the teachers. They will help to "re-place" the teacher, i.e., enable time to play the 'role of guide, counsellor, motivator, briefer of an exploring party, organiser, integrator, critical questioner, and intellectual gadfly'. The role of the teachers in future therefore will change; their work will become more professional. With much routine learning handled by teaching machines and programmed materials, teachers will associate with students in a more meaningful way like guidance and group discussions. They will become 'educational engineers'. In fact, programme development will often require the team work of psychologists, educators, engineers and industrial technologists.

CHAPTER XIII

TEACHING MACHINES

Learning usually involves both a student and a teacher. But in the recent tooling up of the educational system, the teacher need not be physically present to teach. Of late, both the student and the teacher are vitally concerned with the question of acquiring information most rapidly and efficiently. Various teaching techniques have been developed and tested and some have proved their efficiency in this respect. Teaching machines and Programmed Instruction represent this new development in education and have attracted considerable amount of interest recently. "Teaching machines and Programmed materials are not monsters designed to enslave thought and turn teachers and students into robots." On the contrary, these methods act as liberating devices that allow for individual differences. Teaching machines and programmed instruction provide not only better education at lower costs with savings in time but also ensure maximum student achievement. The pioneering work in the field of teaching machines was done by Sydney L. Pressey of the Ohio State University but the peak period of its development came after World War II. The research and writing of B.F. Skinner was chiefly responsible for this remarkable development.

What is a Teaching Machine ?

A Teaching machine is a piece of device designed to be operated by an individual student. It can interact with the student to a remarkable degree. The essential characteristics of the various teaching machines are as follows :

1. The student is presented with a question or problem by some form of display on the machine.
2. The student is required to respond overtly. The student must do something about the problem, either to write an answer or to push a button to indicate the correct answer.
3. The student is informed as to whether his answer is right or wrong. This is being done either by showing the correct

answer or by moving forward to the next frame when a question has been answered correctly.

4. An account is kept of the responses made by the student not for the purpose of testing the acquisition of knowledge but for teaching purposes.

Programming is done by presenting the subject-matter in small discrete interlocking steps, each depending upon the preceding step. Only after the student has committed himself by writing out the response to the problem, he operates a lever or button which exposes the correct answer. At the same time, his answer moves under a piece of glass. The student can only check up whether his response is right or wrong but there is no scope for making corrections.

Most Teaching machines present linear programmes though a few function as branching type. In some of the complex electronic machines, branching of a complex sort is possible.

Like all other 'visual aids' and other mechanical or electronic devices, teaching machines offer much scope as instructional aids but with a difference. While all other means of communication are primarily aimed at teaching masses, teaching machines are intended for individuals. They allow each individual to proceed at his own pace and continually interact with the students. There are machines which allow the student to question, to ask for further information, to demand review and to demand explanation. They are completely *individualised* in every respect.

Types of Machines

Auto-instructional devices exist in a wide range of technological sophistication. They can be broadly classified under two categories namely *constructed response devices* and *Multiple choice machines.* Constructed response devices are based on Skinner's principles namely emission of a response is considered more effective in learning than simple recognition. In multiple choice machines, it is possible to prepare branches for every reply to a given question.

Constructed Response Devices

(a) *The Glider Machine* : This was the first machine developed by Skinner. It acquired the name of sliding machine because the items appeared in window and the student responded by moving sliders containing numbers to produce the correct answer to the question.

(b) *The Disc-Type Machine :* This type of machine contained a large paper on which the questions and programmed material were printed. The disc could be rotated exposing each question in turn in a slot at the topic of the machine. The student wrote his answer to the question on a paper tape that was included in the machine. When the student had responded, a lever was moved which covered the student's response with a glass plate and exposed the correct reply to the question.

(c) *The Typewriter-input Computing Machine :* The computer would store the programme and feed it to the student in a pre-determined sequence. The student would respond by using the typewriter connected to the computer. The computer would then check the response, inform the student and proceed to the next question.

(d) *Audio-Visual Combination :* Skinner has also proposed that teaching machines might provide the student with aural and visual presentation. A tape-recorder could be used to supplement a particular frame in a programme. A television set is perhaps the common example of this combined approach to teaching machines.

Multiple-choice Machines

(a) *Pressey's Machines :* Pressey's machine consisted of a revolving drum and the programme was printed upon the face of the drum. As the drum rotated, the programme was exposed through a slot in the box. The student indicated his response by pressing one of the four buttons. The pressing of the correct button released the drum and permitted the student to move on to the next question. An incorrect response on the other hand did not release the drum. The student ultimately found the correct response in spite of his initial wrong responses. As the correct answer was always the last answer given, Pressey thought that it made the strongest impression on the student.

(b) *Audio-Visual Machines :* Educational television can also be combined with a teaching programme. In this device, a multiple-choice recording device can be attached to any television set. The programme item appears on the television screen. The student responds by pressing one of the buttons on the recording device. The student's performance is recorded on a punched card. The teacher can learn from the cards which students responded to the question and whether or not the response was correct.

(c) *Electronic Computers and Multiple-choice Programmes :* The machine presents a frame to the student for study and a selected group of answers to the question posed in the frame. The student chooses one of the answers and this directs the machine to another page in the programme according to the nature of the response emitted. The pages are microfilmed and fed to the computers earlier. A recording device automatically records the item. In effect, this machine is very much like a 'scrambled book' with a vide attachment and response record.

(d) *Non-mechanical Multiple-choice Devices :* Punch cards consist of small cards that contain multiple choice items. Student records his responses on the card marking it with a special ink. A correct response produced a chemical change and a resulting change in the colour of ink. An incorrect response will not produce any change.

The scrambled book, containing a branched programme printed at random through its pages may also be called multiple choice teaching machine.

Although various types of teaching machines are available for programming learning materials, they have not been standardised so far as mechanical design is concerned.

Values of Teaching Machines

Programmed Instruction and Teaching machines provide a technological solution to the problem of individual differences. Any number of students can be taught with the machines. Teaching machines, if programmed and wisely used, can provide individual experience for students. In the present set up, no teacher can be a tutor to each individual. But auto-instruction can be tutorial instruction.

Teaching machines are helpful from the students' point of view also. Every student can proceed at his own rate of learning. If he is fast, he goes ahead; if slow, the programme is not tired of teaching him as long as he requires it.

Machine vs Teacher

Owing to the advent of teaching machines, teacher's role in a classroom will be changed. Under no circumstances the teaching machine can replace the teacher. For the overworked teacher burdened with large classes, teaching machines are helpful. The need for the teacher to inspire and motivate, to guide and correct is in no way diminished by the development of these machines.

Teaching machines are primarily due to the work of educational and research psychologists. The machines may appear crude as they are today. But painstaking research is still going on and it will definitely improve the technique so that teaching will become the most human of all professions.

The greatest value of such mechanical devices and the programmed material used in these is that they make *individualisation of instruction* possible. Programmes catering to individual differences among pupils should take into account not only speed of learning but also other physical and psychological variables found in classes. Individualising instruction is not just paying personal attention to each pupil. It consists of designing specifically tailored learning experiences for each pupil on the basis of his or her needs and interests as well as strength and weaknesses. In such a task the planned use of the tools and techniques of Educational Technology is indispensable.

Computer-Assisted Instruction (CAI)

Today computers are widely used in business and research. Its applications are enormous. They help guide astronauts and space capsules. It counsels students, controls betting at race tracks and chooses the ideal mate for cautious bachelors. It grades the university students, diagnoses football strategy, plays chess and war games. The efficiency of human beings as data-processing organisms is also being challenged by the computer. The computer can do million calculations within a second. Almost in every field of human activity, computers can stretch its arms and make it perfect. A computer is the most important invention which man has found out since the invention of printing machine. While printing has amplified the process of information transmission, the computer has amplified the possibility of information processing. With all these developments, computerisation is 'still in its infancy. What lies ahead may be beyond the reach of our imagination.

What is Computer ?

A computer is a power-driven machine equipped with key boards, electronic circuits, storage compartments and recording devices for the high speed performance of mathematical operations. In simple terms, a computer is a 'glorified calculator' with a difference. It has in addition, a capacity for storing or "memorising" a large amount of information and producing or retrieving any of them when called for. As a tape-recorder stores the information in audio-tape, a computer stores information. The computer is a box loaded with information. Information and problems are translated into computer language so that it can understand. The procedures and formulae necessary to process the information are also fed into the computer. When related information is given to it, it interacts and manipulates the information, translates the answer and types it on a teletyperwriter.

How Does A Computer Work ?

A computer consists of five basic parts :

1. Input equipment
2. Output equipment
3. A memory store

4. A processing unit
5. A control unit.

The input equipment translates the information from the user into a form which the computer can use, and the output equipment translates information back into understandable form. The memory store contains all the information which has been fed into the computer through the input equipment. The processing unit operates and processes the information. It can add, subtract or multiply. It can also select particular information out of a large amount of stored information in terms of scientific criteria. Its actions are determined by the control unit in accordance with a programme.

Usually two kinds of information are fed into the computers : a programme consisting of a *set of instructions* and *information* which this programme will operate on. Both sets of information are stored in the memory store.

Computers in Education

Computerisation in education is in its infancy. However, the computer is bringing some exciting innovations to education. The following are the areas in which computers are helping the educators.

(a) Computers take over the most of the drudgery of schooling, like classifying children according to abilities, preparing time table, schedules, etc.

(b) Computers allocate learning resources to individuals and groups.

(c) Computers maintain progress cards and preserve them confidentially.

(d) They provide easy access to files of information for reference and guidance.

(e) They provide direct interaction between student and the subject matter to be learned.

(f) They engage the students in tutorial ineraction and dialogue.

Computer Assisted Instruction (CAI)

The most exciting innovation in the educational technology is the Computer Assisted Instruction (CAI). Though it is still in the experimental stage, the day is not far off when it will revolutionise the whole process of instruction.

A computer is programmed with linear or branching programmes. It acts like a super teaching machine catering to the needs of a number of students at the same time. The characteristic aspect of the CAI is its capacity to initiate flexible interactions with the student which is not possible in the teaching machine. There are a number of ways in which this can be brought about. The computer is able to record and store all the responses of all the students. It can use the information in deciding what information to give the student next. It can branch not just in terms of one answer but also in terms of a whole series of previous answers. It can also record the time taken to answer a question and the degree of correctness of the students' response. It uses the information in planning to determine which branch to take.

A typical CAI installation consists of individual learning booths, each with a console. The student is seated. Facing him on the console is a television screen for displaying information. Before he starts a programme, the student checks in with the computer by displaying his identity number. This connects him with his part of the learning programme. A complete package of information stored in the system is presented sequentially. This information could take the form of video-tape recordings, slides, motion picture films, filmstrips etc. The student may question the computer and feed answers into it by means of a typewriter keyboard. The computer responds by printing out comments, answers and questions. Sometimes, the student may write directly on the cathode ray tube display screen with a 'light pen'. His answer will be picked up by the computer and evaluated. When he has finished, the computer assigns him the next programme, records his progress and prints out a report for his teacher.

The CAI starts by identifying the way a student seems to learn best. It reviews his past history of learning and then presents a programme built on his strength. Sometimes the computer stores all the information gained from all students who have taken the computer course previously. This information may be re-analysed and much of the teaching strategies which were not effective may be rejected and strategies which have succeeded may be continued.

Computer assisted instruction is therefore not merely a sophisticated type of programmed instruction but a different kind of instruction altogether. No doubt, it uses programmed instruction but it also uses electronic data processing, data communication, concepts of audio-visual and media theory, communication theory, systems theory and learning theory. In contrast to CAI, computer managed instruction (CMI) analyses the relationship between various factors pertaining to a pupil and suggests activities appropriate to individual students. This includes PLAN (Programme for learning in accordance with Needs) of J.C. Flannagan and IPI (Individually presented instruction) of Cooley, W.W. & R. Glaser.

In general, students learn well with CAI in considerably less time.

Instructional Uses of Computer

Although computers can be used in many ways in the educational programmes, the following are some of the areas where it proves to be effective in the instructional process.

1. *Drill and Practice :* The student sits at a specially designed electric typewriter which is connected to a computer by telephone lines. He identifies himself by a code number and his name. The machine types out the first question and the student responds. Soon the lesson is under way. The computer keeps track of each student's performance and can 'read back' to the teacher a summation of each student's work whenever the teacher wants it. Depending upon the programme, the student might be referred to a branching type of remedial exercise. As in programmed instruction, student moves at his own pace, gets immediate feedback and receives individual tutoring.

2. *Tutorial and Dialogue :* The subject-matter is literally taught by the computer programme. Explanations are given orally through audiotape and needed visuals presented in cathode ray tube as in television. The student responds on a typewriter keyboard or by pointing on the screen with a light pen. The computer reacts to student's response by 'talking' to him. Student makes further response. A kind of dialogue takes place between student and machine. The Talking Typewriter developed in 1966 by O.K. Moore also serves a similar purpose.

3. *Simulation and Games :* These have come into effective use in education during the past decade. Simulations are condensed learning exercises specifically designed to represent vital real life activities by providing learners with the essence or essential elements of the real situation without its hazards, costs or time constraints. Sinulations are realistic imitations. Simulations are frequently planned in the form of competitive games to increase motivation and interest. Organised Social simulation is called gaming, as for example, historical games. Simulated learning came into prominence during the Second World War when extensive use of this was made to train recruits in psychomotor skills as aircraft flying, weapon system operation, etc. Now simulation is used in teaching various subjects as well as in areas like teacher training. Simulation may involve simulator trainers or mock-ups which are really 3-dimensional teaching aids e.g., an aircraft flight simulator. Role playing is also a type of simulation, ranging from simple make-believe to play acting and drama. Educational simulation and games like all other well organised learning experiences must be carefully designed and clearly specified objectives. The most obvious uses of simulation are in extending the experience of pupils and in stimulating their interests. Simulation and gaming increases motivation and self-confidence and can

accommodate students of different ages and levels of maturity. They approximate reality far more closely than conventional class methods. But some of these take considerable time and demand too much from the teacher.

4. *Information Handling :* One area where processing and information handling capacity of computer is profitably used is counselling and guidance. Computers store complete cumulative records and match them against employment needs and potentialities.

Advantages of CAI

Computer assisted instruction proves better than all other aids in several respects. There is not only saving of time in learning but it also performs miracles in processing the performance data. This latter characteristic helps to determine subsequent activities in the learning situations. The large amount of information stored in the computer is made available to the learner more rapidly than any other medium. The dynamic interaction between the student and instructional programme is not possible to be secured in any other media. With CAI, we would completely individualise materials.

Before computers can be of any use, they must be carefully programmed to perform desired functions. This requires thorough planning of every step and prior thinking. Computers are simple minded. They demand instructions spelled out in explicit detail. Human beings are brilliant but rather sloppy thinkers; computers are stupid but accurate.

Limitations of Computers

Although computers open the possibility of educating the students completely by individualised programmes, its chief limitation lies in the fact that it is prohibitively costly. Computers may also inject a non-human quality into educational programmes. This new technology may 'dehumanize' man. Further all individualised instruction and CAI instruct the students om sicj a wau as that all will achieve the same competency.

Teacher and CAI

Computer Assisted Instruction is not to exclude the teacher from the classroom. Machines mean relief from the more mechanical aspects of the teachers' work. Teachers need no longer be 'talking books' or 'paper correcting automatons'. They can hereafter work in areas like evaluation, planning, curriculum revision, guidance and human relations. Although we cannot forecast the areas wherein computers may be helpful in future, the possibilities of their effective use in the educational scene are enormous.

In addition to machines intended for auto instruction, educational technologists also recommend *systems approach* facilities which represent an integrated and programmed complex of media, machinery as well as personnel whose components are structured as a single unit with a time schedule and sequential phasing. The systems approach utilises the principle of 'cross media approach' to instruction, with a variety of related material reinforcing the instructional effect of each other. Many such media-machine system facilities have been developed in the West for different purposes. For example the 'systems concept reading unit' contains a tape recorder, a controlled reader, a tachistoscope for brief exposure of reading material, headphones, tapes, film strips, books, etc., needed for a reading programme. Electronic 'Learning Laboratories' with similar hard and software. '*Dial access retrieval systems*', '*Multimedia consoles*' for class use and similar machine systems are also available. The classroom teacher can build up instructional system facilities for his use around important subject content units using the available facilities and innovating needed media.

CHAPTER XIV

INSTRUCTIONAL RESOURCES CENTRE

Planning an Instructional Resources Centre

The methods used for instructional purposes are generally the following :

(1) Lecture

(2) Lecture Demonstration

(3) Individual practical work in the laboratory, workshop

(4) Field trips

(5) Planning and completion of projects.

These methods are often followed by other means of consolidating knowledge acquired like.

(a) discussion in small groups guided by the teacher

(b) seminar and conferences

(c) assignments done at home=reading books and doing home work.

Individual attention is given by tutorials and use of programmed instruction and teaching machines.

Varied activity will prevent boredom and use of multi-media is necessary on many occasions to make pupils fully understand the particular subject area. Use of Teaching Aids become a necessity whatever method is adopted. The teaching aids vary in nature and complexity from the simple but necessary and effective chalkboard diagram to the closed circuit television.

The right type of aid should be used in the right way at the right time. It will be necessary to have the required aids for use. Suitable facilities should be available to make use of the available aids.

Some aids could be improvised. Some aids could be easily fabricated. It will be necessary to purchase some aids. The aids are used in the classroom. The facilities in the classroom should include the following :

(1) Gallery accommodation would be most suitable for pupils observing demonstrations;

(2) A good sturdy demonstration table should have electric power supply, water supply with sink arrangement, gas supply for burners and provision for screwing iron or aluminium uprights at various points;

(3) Chalkboard of sufficient area erected at suitable height is a must;

(4) Magnetic display board fitted by side of chalkboard;

(5) provision for hanging charts;

(6) provision for locating projectors in rear of classroom and electric power provision;

(7) provision for portable projection screen to slide over chalkboard whenever necessary;

(8) provision for thick curtains to windows and doors for use to darken the room during projection.

(9) a 1 cm thick 3′ × 6′ joly board suitably coloured fixed to wall for pinning displays; and

(10) a pegboard fitted to wall.

A small workshop with a carpentry bench fitted with bench vice and full complement of carpentry and metal working tools will be necessary. Portable power tools would help matters considerably. There should be adequate stock of raw materials.

A general planning and graphic aids production room is necessary. The room could contain work benches, drawing tables with mini drappers. Water supply in this room is necessary.

A photography darkroom with work benches, enlarger, printers, safe lights, necessary developing dishes etc is necessary for preparation of projection materials.

Aids that could be prepared in the media centre :

(a) Graphic aids

(b) projection materials
    non-photographic
    photographic

(c) models—simple sectional
    static
    working

Classroom Accessories

(1) *Chalkboard*

Ideal Chalk Board is one made up of plane glass ground on the front side and coated with green or black paint on the polished backside mounted on wooden frame and fixed to wall. (Size 3′×6′ or two 3′×6′ boards fitted side by side.)

(2) *Display Boards*

Joly Board—Insulex—suitable size can be mounted on wooden frame and fixed in classrooms and laboratories—suitable for use as a Notice Board or for displaying suitable pictures—may be painted with destemper or covered with cloth.

Magnetic Board—suitable size mild steel sheet mounted on wooden frame and fitted on wall.

Felt or Flannel Board—suitable size felt or flannel stretched over hard board mounted on wooden frame and fixed on wall.

Perforated Hard Board—suitable size, painted, mounted on wooden frame and fixed on wall—pegboard.

Plastigraph Board—glass plate painted with suitable colour on back and framed.

(3) For hanging charts in classroom, slotted angle may be fitted on chalkboard frame at the top and other convenient places in classroom.

(4) Screen for use with O.H.P. may be improvised using painted board or joly board—(plastic emulsion paint would be suitable)

(5) Portable demonstration table—suitable design

(6) Quick darkening provision to be made available in every room.

Materials and Tools Required for the Preparation of Teaching Aids

A. Graphic aids

White drawing paper
White cartridge paper
Black cartridge paper
Coloured cardboard (assorted colours)
Coloured poster board (,,)
Coloured poster paper (,,)

Poster colours—25 or 50 m.l. (assorted colours) including fluorescent poster colour
Poster colour—White (large jar)
do —Black (large jar)
Ruling pens
Funnel pens, Holder (Nos. 1 to 6)
Brushes, Camel or sable (1 to 6)
Flat brushes, 1, 2 cms.
Fevicol
Script pen nibs with holder
P.V.C. Self-adhesive tape—1″ (assorted colours)
1″ gummed paper tape
Felt markers (assorted colours)
Felt marker inks (,, ,,)
Letter stencils — complete set
Colour mixing dishes
Reaper wood section—1″ × ½″ (for mounting charts)
Eyelets
Disc magnets (ceramic) 1 cm × 5 mm (round) thick
Paper clips—assorted sizes
Pencils—2 H, H and B; Brasers
Scissors.

Other Equipments : Drawing Table/Drawing Board/Minidrafter/Pantograph/Plastic Scales 50 and 100 cms/steel foot rule/Engineering instrument Box (Drawing)/Set-Squares, T-squares and French Curves/Episcope or Epidiascope for copying from books. *Optical Pointer* (Portable), Electric pointer to point out details on the screen. White screening are now available. These are battery operated and focus a bright image of the lamp filament through a lens. In some bulbs the glowing filament is shaped like an arrow.

B. For Fabrication of Models :

Adequate stocks of :
Dealwood planks (assorted thickness)
Chalkboard paint Black
Glass paper (sand paper)—assorted grades
Emery sheet
Wood screws—assorted sizes (nuts)
Wire nails ,,
Wood primer and wood point

Metal primer—Enamel colours for metal
Straw board—assorted thickness
Joly board—1 cm thickness
Hard board ,,
Plywood ,,
Formea sheets
Slotted angles (assorted sizes)
M.S. Sheets (18 and 20 gauges)
Brass and copper sheets (22 gauge)
Thermocole—2 cm/5 cm/and 10 cm thicknees
Distemper (water based) for colouring thermocole
Fevicol
Berspex sheet - assorted thickness (opaque, clear transparent and clear transparent tinted)
Chloroform
Hypodermic syringe 5 ml
Araldite.

Improvised Tools :

Thermocole cutter/Linear heater for bending perspex sheets/Heater (round) for softening perspex for moulding/spare 1000 w. heater element/glass bottle and Tube Cutter.

Additional Tools Required : In addition to the tools available in the workshop the following tools may also be required :

Work Table with 4″ fitting-vice fixed/Tables/Bench grinder/0.6 c.m. capacity electric drill/Stand for electric drill/One set of high speed drill bits/B.A. Tap and dies (one set)/Assorted set of files/ Wood working tools/Hand saw/Metal sheet cutting shears/Hack saw/Pliars (combination vice grip and long nose) Hammer (assorted type)/Auto transformer (Dimmerstat)—2 and 4 amperes.

For Making Electrical or Working Models

Different gauges of enamel insulated copper wire will be required. Also flex wire, V.I.R. Wire and assorted sizes terminals will be needed.

C. *For making Projection Materials (Slides, O.H.P. transparencies, Filmstrips etc.*

35 mm camera with provision for focussing up to 25 cms. (A single lens Reflex Camera would be ideal as it could be used to focus

even upto very short distances by improvised accessories). Photographic dark room, with running water provision and other darkroom accessories like safelight, dishes, etc., alongwith.

Processing chemicals
Enlarger
Reflex copier
Reflex printing paper
Diapositive acetate film (Indu) sheets
35 mm negative film (ORWO, AGFA etc,)—show film—(100 A.S.A.)
35 m.m. diapositive film (Indu)—in roll
Bromide paper (Different grades)
Cellulose tri-acetate sheets for O.H.P. transparencies
Colo chisel marker (assorted colours)
Rapidomat pen sets
Camel rapidograph ink
Hecto carbon paper
Chinagraph pencils
Cardboard,—rigid (for use as file covers)
Stapler
P.V.C. tape—½″
Transpaseal (assorted colours)—may be imported.

D. *Projection Equipment*

Epidiascope with 100 w. lamps
Film strip—slide projector
16 mm sound film projector
Portable matte or fended screen on stand
Overhead Projector
Splicer—Rewinder for 16 mm film
Screen for O.H.P. and rear projection screens could be improvised
Loop cassette projector—8 mm super (Sufficient stock of projection lamps and exciter lamps should be maintained)
Two track portable cassette tape recorder.

E. *Reprography Equipment*

Ink duplicator
Stencil cutting accessories—wheel pen, dot pen, etc.
Electronic stencil cutter

Spirit duplicator
A-4. Screen printing equipment.

The Photographic Darkroom—Accessories

A. Equipments

1. *Camera* : At present highly sophisticated cameras are not manufactured in India. Only a few makes—Agfa Isoly 1, Agfa Click, Bunny, Sureflex, etc., for use with 120 films are manufactured. Cameras using 35 mm perforated film are economical. Canon, Kodak, Retina and other kinds with range finder coupled to focussing and some with automatic exposure controls could be imported by any educational institution with a special import permit. However, any camera manufactured in India would be quite adeqate for pupils.

   All have provision for using flash. Using spectacle lens 4, 3 etc. as supplementary lenses, and calibrating the camera using a ground glass plate, even extreme close-ups could be attempted.
2. A good tripod (collapsible) would be useful but not absolutely necessary.
3. Yellow and orange filters may be purchased, if available.
4. Electronic Flash working with battery or 240 volts A.C. may be purchased if funds are available.
5. Printing frame 12″ × 10″ or 8½″ × 6″ and one smaller size 3½″ × 4¼″ or post card size will be a necessity.
6. Dishes—Plastic to be preferred (or enameled iron) two numbers to take 12″ × 10″ papers would be useful.
7. Plastic bucket—2 nos. for keeping water is essential.
8. 1000 ml polythene mugs—2 nos. useful for mixing solutions.
9. A 1000 ml measuring jar will be useful.
10. Plastic spoons 1 dozen will be useful.
11. Glass rods for stirring required
12. 31000 ml dark brown or amber coloured bottles with glass stoppers could be used for keeping solutions.
13. Universal developing tanks—2 nos. will be adequate.
14. Safe light—1 no; 3 filters—red, green and yellow—could be used on all occasions.

15. Thermometer 110° C to measure the temperature of developer.
16. Stainless steel forceps for handling prints.
17. A stop clock or process timer is necessary.
18. Enlarger—2 nos.—one for enlarging from 3¼″×2¼″ negatives and anothor for enlarging from 35 mm negatives.
19. Enlarger easel to take prints upto 15″×12″ is a necessity.
20. One number enlarger picture magnifier will be useful for focussing.
21. For Reflex printing, the necessary equipment could be improvised.
22. Trimmer—1 no.
23. Print roller for use with glazing sheet is necessary.
24. Electric glazing machine could be purchased if funds are available.
25. A hair drier will be useful for quick drying of prints.

B. Chemicals

1. Metol or Elon	25 grams
2. Hydroquinone	100 ,,
3. Sodium sulphite (anhydrous)	2 kgms
4. Sodium carbonate (,,)	3 kgms
5. Potassium Bromide	25 grams
6. Borax	25 ,,
7. Chrome Alum	250 ,,
8. Hypo (Sodium Thio sulphate)	5 kgm
9. Potassium or Sodium metabisulphite	500 grams
10. Potassium ferricyanide	250 ,,
11. Ferric Ammonium Citrate	250 ,,
12. Mercuric chloride	25 ,,
13. Liquor Ammonia	500 ml
14. Sodium sulphite	250 grams

C. Other Items

1. Brushes for retouching—camel	2 each
2. Brushes for cleaning lens	2 nos
3. Transparent water colour	1 Book
4. White ink—25 ml	1 bottle.

5. Lens cleaner—25 ml	1 bottle
6. Liquid opaque—25 ml	1 bottle
7. Mounting paste	1 bottle
8. Cloth polishing	2 nos
9. Good scissors	1 no
10. Plastic scales (transparent)	3 nos

For weighing developer chemical balance, weight box with fractional weights could be got from the science laboratory.

Dark Room : A room 6'×12' walls blackened with dull black coating containing a long table 2' wide and 2½' height would be adequate. Plug points could be provided in the room. Provision for bolting the room is essential. Running water and sink, if provided, will make the room ideal. Materials can be stored in almirah outside. Ventilation could be provided using light baffle windows and fans.

D. Sensitive Materials

Negative films	— 35 mm 20 exposure cassettes 35 mm 36 exposure cassettes 120 films
Fast film	NP 27 (Orwo)
Slow film	NP 22 (Orwo)

35 mm Film—*Release* positive—Indu

Dia Positive Acetate film—Indu

Graphic aids Acetate film—Indu

Reflex Printing Paper—Agfa—Indu.

APPENDIX-I

RELATIVE ADVANTAGES OF DIFFERENT METHODS

1	*2*	*3*	*4*
No.	*Method*	*Ideal for*	*Should not be used for*
1.	Lecture	For presenting factual and informational, material should be planned properly and punctuated with suitable demonstrations and/or media for effectiveness. Continuous feed-back during lecture from pupils to find out extent of learning outcome is necessary.	Presenting too many details For development of skills
2.	Demonstrations	To Make pupils learn about principles and phenomena; to show manipulative operation of any equipment; to explain a process	As a substitute practice Just to spend time or fill in time
3.	Individual practical work	To make pupils fully under-stand principles, phenomena and processes by investigation. Provides direct experience.	For merely spending time

4.	Individual work in workshop	To develop specific skills; To learn about operations of machines; Enabling pupils to complete any undertaken project or fabricate any specific article; Activity should be purposeful	
5.	Field Trips	To provide direct experience in a natural setting; To highlight pragmatic applications of knowledge; Should be well planned for effectiveness.	For merely going out seeing places
6.	Projects	For making pupils comprehend fully what they learn—Activity based ; To make pupils realise the pragmatic use of knowledge; Direct, purposeful, correlated activity in a natural setting.	*Constraints*—The method requires an experienced teacher to provide the necessary resource materials and guide the completion of the project
7.	Discussion	For use with small groups only (at the most about 8 pupils; To promote better understanding; To review areas already dealt with; To motivate pupils to think.	To present material which is new; To consolidate learning; Will not result in any outcome unless the teacher is present to guide and steer the discussion

8.	Conference, seminars, etc.	To provide sharing of experience and knowledge; To encourage group thinking; To develop understanding.	If all the participants do not know about the topic, the benefit will be very minimal; No new programme should be stated with a seminar.
9.	Class, workshop and home assignments	For consolidating knowledge; For understanding applications of knowledge.	
10.	Reading	Highlighting or emphasising specific aspects of a topic;	
11.	Tutorial (individual)	To meet the specific needs of the individual.	Pupils do not have the advantage of working with the group and hence lose the associated benefits.
12.	Programmed Instruction/ Teaching Machines/Media packages for self learning specific subject areas.	Learning at home; Individual learning at own rate; Provision of scope for self evaluation.	Not practicable for covering the entire syllabus.

APPENDIX II

AIDS TO PROMOTE EFFECTIVE LEARNING—COMPARATIVE STUDY

Tool Hardware	*How to use*	*Features and Utilisation*	*Conditions for Use*	*Accessories*	*Software available*	*How many needed*	*Maintenance*
2×2 slide viewer	Individual or small group instruction depending on type of viewer	Student can use alone in classroom or industrial arts resource centres. Ideal for students in make-up work	With proper screen little or no darkening of the laboratory is necessary	Some models built-in screens in covers, slide carriers, slide trays, manual or automatic changers, automatic timers, remote control changers, adapters for single-frame vertical filmstrips	Information available from manufacturers. Teachers can themselves make slides	One in each laboratory, one in resource centre	Low

II.	T V receiver (C. C. T. V.)	Small or large group instruction	Useful in areas where space or safety limitations prevent students from clearly viewing demonstrations	School plant must be specially equipped	Auxiliary speakers, glare shields, coaxial cable with impedance matching, transformer for connecting 300 ohm antenna or camera system	Commercial TV stations often broadcast many programmes. But teachers must develop own TV films for use in regular lessons, possible	Considering cost one is usually enough if a planning room or resource centre is available	Normal TV maintenance
III.	Audio-Tape recorder (Listening station)	Used with individual or small group instruction can be used with other audio-visual equipment	Ideal for make-up lectures or dictated tests	Needs earphones and jacks. Students use the equipment independently. Need not disturb teacher or classmates	Earphones, Jacks. sound proof individual desk units	Teachers must record own tapes to suit lessons	One per lab or resource centre	Specialised maintenance needed

IV.	Portable Video-tape machine	Entire class viewing	Instructors and students can programme tape to be used for classroom demonstrations. Avoid crowding around machines where safety problems could arise	Can tape teacher's demonstrations, allowing him freedom to work with students	Portable video monitor special effects generators, empty reels, wide angle lens, telephoto lens, vidicon camera	Both sending and receiving equipment is necessary (see TV Receiver)	One in a resource centre	Requires specialised maintenance
V.	Tape recorder and Record player	Small or large group instruction replaying recorded educational broadcasts	Lectures may be given during teacher's absence. Students may review lecture as they wish or listen to recordings	None	Additional speakers, microphones, stereo head phones, earphones	Spare reels, 2 track tape, check catalogs/disc records (33½,45,78 r.p.m. discs)	One per department	Specialised maintenance may be sometimes needed
VI.	Transparency making equip-	To make transparencies for use	Can be used to make transparencies	None	Carrying case, dust cover	Light sensitive transparency blanks, laminages	One per department	Specialised maintenance

	ment	with overhead projector						
VI. (a)	Wall charts and posters	Small or large group instruction	Can be used for a variety of purposes				as many as available	No maintenance problem
VII.	Filmstrip Projector or Slide Projector	Small or large group instruction	Can be used for 2×2″ slides or 35 mm filmstrips; teacher may stop and discuss any time. Students can assist by reading or operating the projector during class	A darkened room may be necessary	Dust cover, carrying case lenses, automatic timer, remote control film advance, rewind take-up self-contained unit with screen, PA system in some models	Many commercially available 35 mm filmstrips, check film and audio-visual catalogs	One for each area in the department, one for the resource centre is ideal	Low, but specialised work may have to be done
VIII.	8 mm sound projector	Small or large group instruction	Through commercially available films, more up-to-date information	Same as 16 mm motion picture projector	Loudspeaker 20 mm to 32 mm f/1 Projection zoom lens, Universal	Check catalogs for film listings	One per department	Specialised maintenance necessary

			can be brought into the classroom to assist the industrial arts teacher in clarifying lessons		splicer, remote control microphone, variable speed control, automatic and semi automatic threading devices, stop motion devices			
IX.	16 mm sound projector	Small or large group instruction	Can be used in classroom or laboratory	Darken room except for newly developed daylight screen	Speakers 10 and 25 hour 1000 watt lamps, protective covers, and morphis attachments, automatic threading devices, remote control, wide angle lenses	Commercial films available; consult film catalogs for lists of films for rent or free. Some teachers can make their own films	One per department is usually enough	Specialised maintenance may be necessary

X.	Continuous loop film projector	Individual or small group instruction ideal but can also be viewed by a large group	Continuous loop enables students to review materials as they wish	Some darkening of the room may be necessary	Carrying case, screen, automatic cartridges, zoom lens, auxiliary speaker, listening centre (head phones)	Empty cartridges, film splicers, make use of the film strip projector one of the newest and best audio-visual aids on the market	Two or three would be ideal but one per department is usually enough	Low
XI.	Overhead Projector (Transparency) Projector	Whole class instruction	Can be used in a lighted room or laboratory with teacher facing students during presentation	None	Roll feed attachment built-in projection pointer, heat filter carrying case light flash hield copy trays plastic dust cover	Much software available but transparencies can easily be made by the teacher	One per department enough two or three optimum	Low

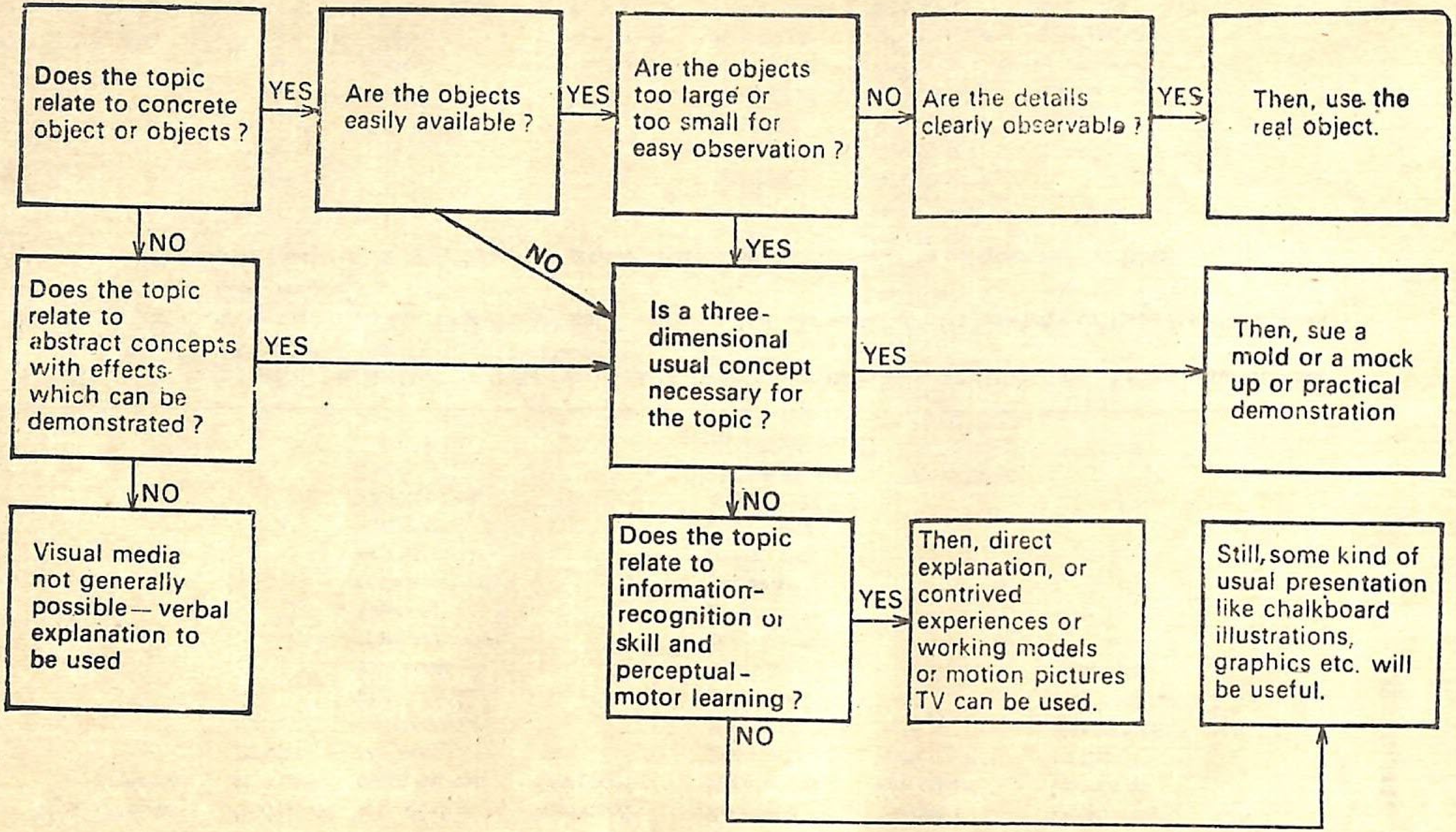
XII.	Opaque projector	Individual or small group instruction	Use of this machine can replace overhead projectors and some transparencies. Pages of books, reports or charts can easily be projected on a screen	Darkened classroom	Roll feed attachment glass pressure plate dust cover built in projection pointer, padded cover, side copy trays heat filters carrying case, light flash shield	Teachers can make own	Depending upon size of the department two or three sufficient	Low

Note : (i) *Programmed Instructional material* for different areas are commercially available and the resourceful teacher can prepare such materials with training.

(ii) *Computers* use a variety of preprogrammed material, but are costly and not available in India for educational purposes generally.

(iii) *Systems combinations* (TV, films, still pictures, Audio Recordings) are also not generally available.

APPENDIX—III Criteria for Selection of Visual Media


Does the topic relate to concrete object or objects ?
YES
Are the objects easily available ?
YES
Are the objects too large or too small for easy observation ?
NO
Are the details clearly observable ?
YES
Then, use the real object.
NO
NO
YES
Does the topic relate to abstract concepts with effects which can be demonstrated ?
YES
Is a three-dimensional usual concept necessary for the topic ?
YES
Then, sue a mold or a mock up or practical demonstration
NO
NO
Visual media not generally possible — verbal explanation to be used
Does the topic relate to information-recognition or skill and perceptual-motor learning ?
YES
Then, direct explanation, or contrived experiences or working models or motion pictures TV can be used.
Still, some kind of usual presentation like chalkboard illustrations, graphics etc. will be useful.
NO

APPENDIX IV

EXAMPLE OF BRANCHING PROGRAMME-MICROPHONES

(Cards to be used with a teaching machine—on pressing the lever in the chosen slot the card with the next sequential information will be presented)

CARD—1

Photograph of a speaker
in front of 2 microphones

Are you able to identify the objects before the speaker? Yes. Your guess is correct. The speaker is talking before a microphone. There are two microphones. Why are they kept before the speaker?

If you know press lever in slot C
If not press lever in slot D

CARD—2

Your answer was 'yes' well—Do you know that there are different types of microphones? Are you able to identify the type in the picture? If you want to confirm the accuracy of your knowledge press lever down. Slot A for further information.

CARD—3

You did not know about the objects kept before the speaker and their purpose. The objects kept before the speaker are microphones. The sound made by the speaker falls on the microphones diaphram which vibrates. A coil fixed to the centre of diaphram also vibrates. The coil is located in a radial magnetic field varying electro-moving force induced is amplified by an amplifier and amplifier output is connected to a loudspeaker which reproduces original sound louder.

CARD—4

Mircophone, Amplifier and
Loudspeaker are essentials
of a sound system

1. Microphone provides varying EMF—varying in accordance

CARD—5

You are correct. The microphones placed before the speaker are moving coil microphones—called dynamic microphones. Do you know about moving coil microphone. If yes press lever down slot

CARD—6

Good—you know about the construction of the Dynamic Microphone

Press lever down slot A to know about other type of microphones with sound made.

2. Amplifier amplifies varying EMF.
3. Vibrations in loudspeaker diaphram reproduce original sound louder.

Now start again.

C; if no, press lever down slot D

CARD—7

You need not know about constructional details of a dynamic microphone

1. Moving coil version
2. Velocity microphone

Principle—when conductor moves in a magnetic field EMF induced.

Now press lever down slot B for further information.

CARD—8

The other types of microphone are carbon microphone.

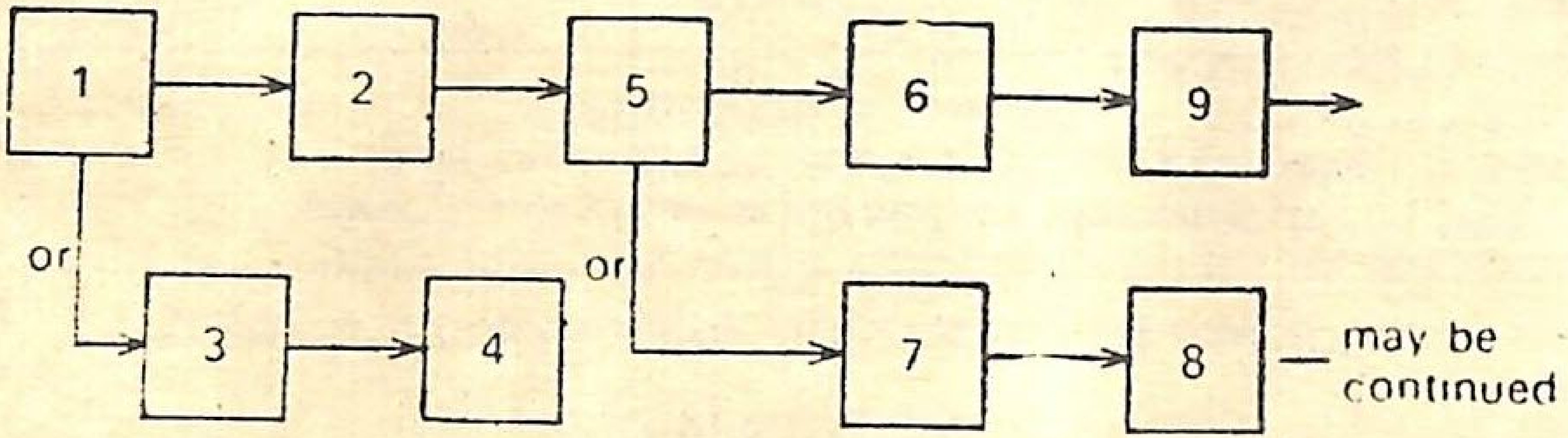
Now you run through the programme again. But first write down what you have learnt and put down the same on paper.

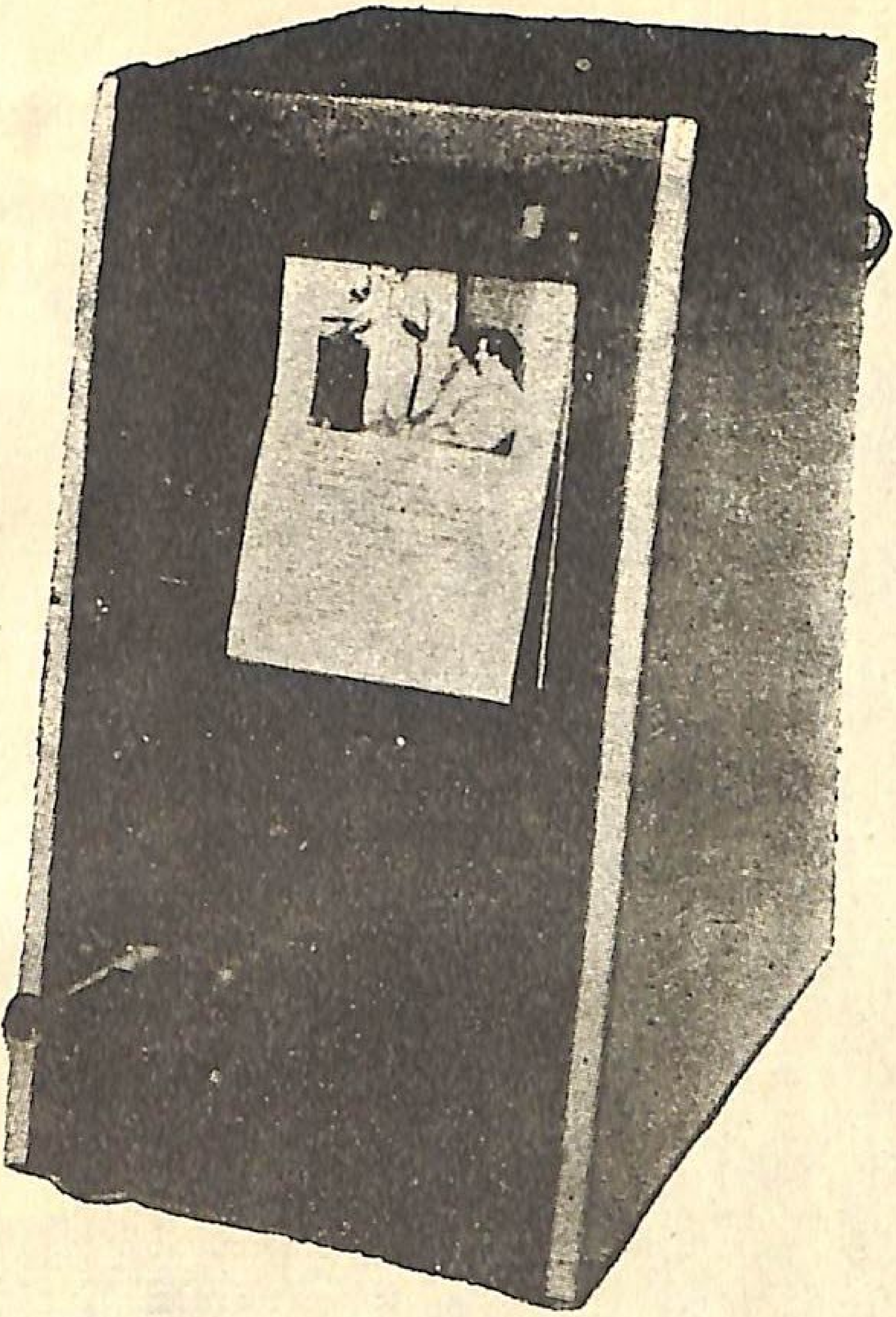
CARD—9

The other types of microphones are:

1. Carbon microphone now used only in Telephone
2. Crystal-ceramic microphone using Prezoelectric effect
3. Condenser microphone
4. Velocity microphone go through part II of programme on microphones for further information.

Branching sequence of the cards





Branching

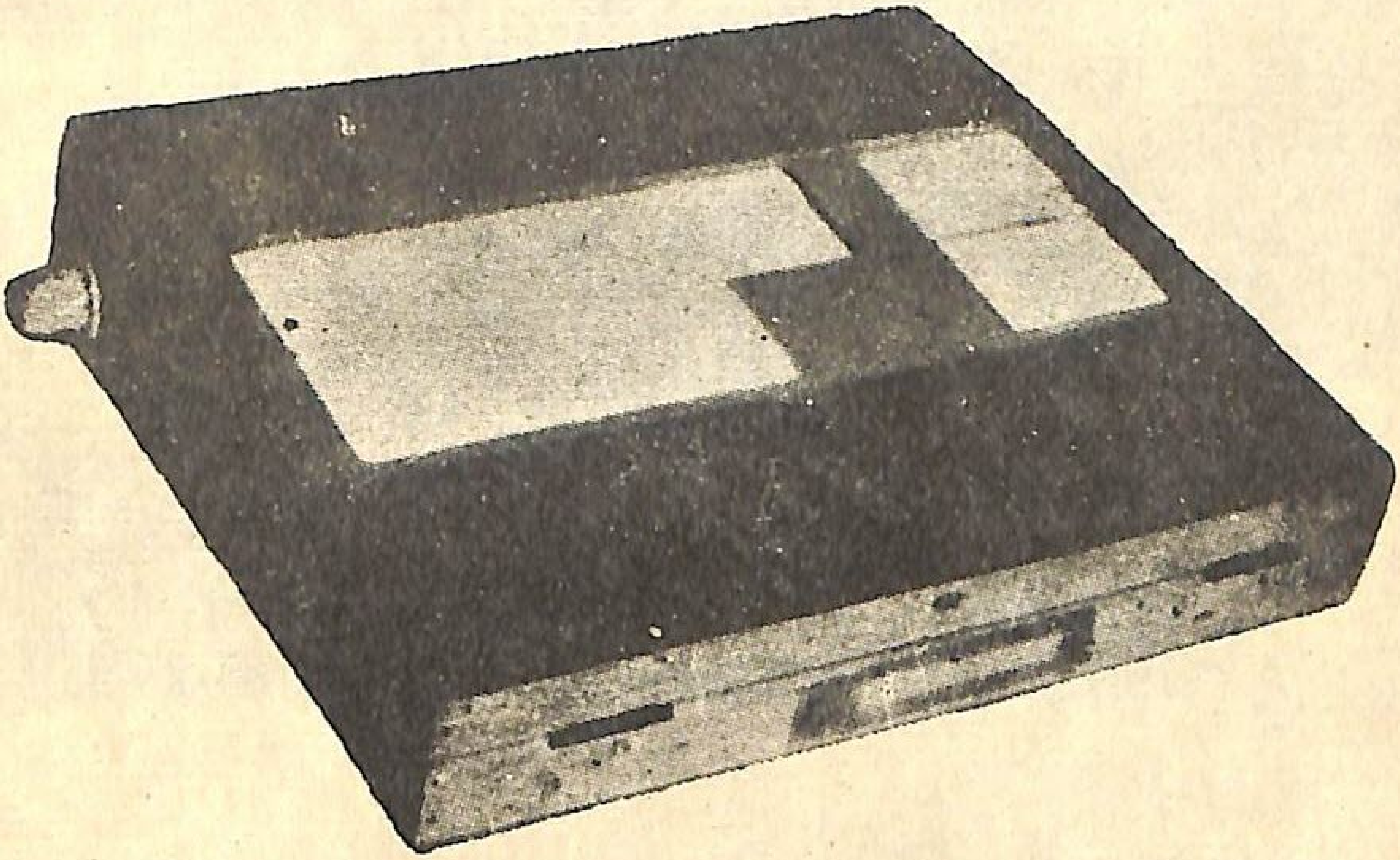
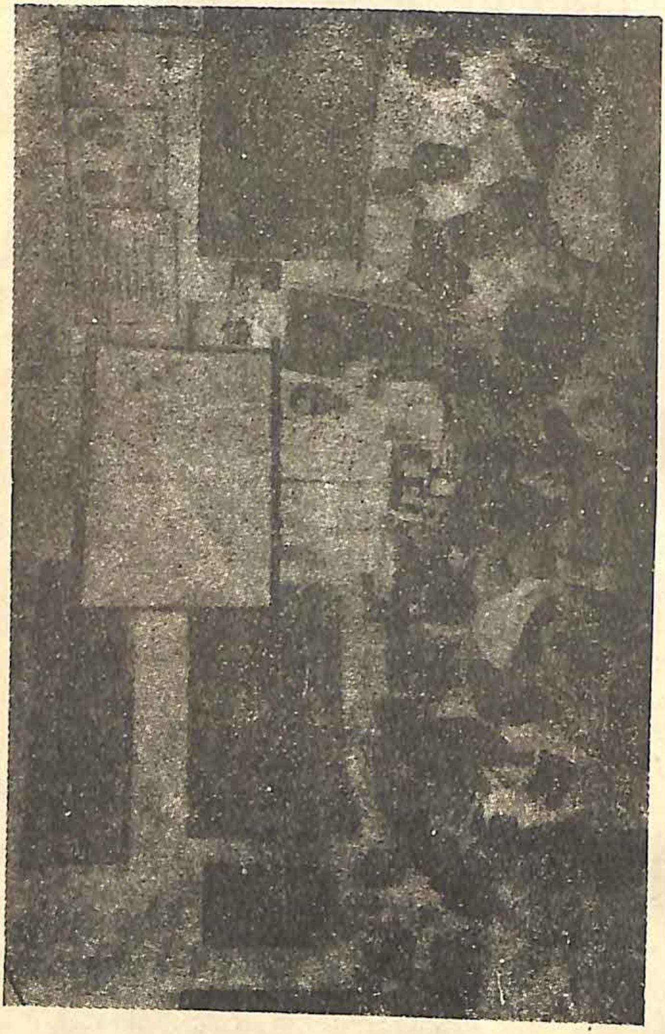


Fig. XIII. 1.
Teaching Machines

Linear



Appendix 1
Typical Classroom

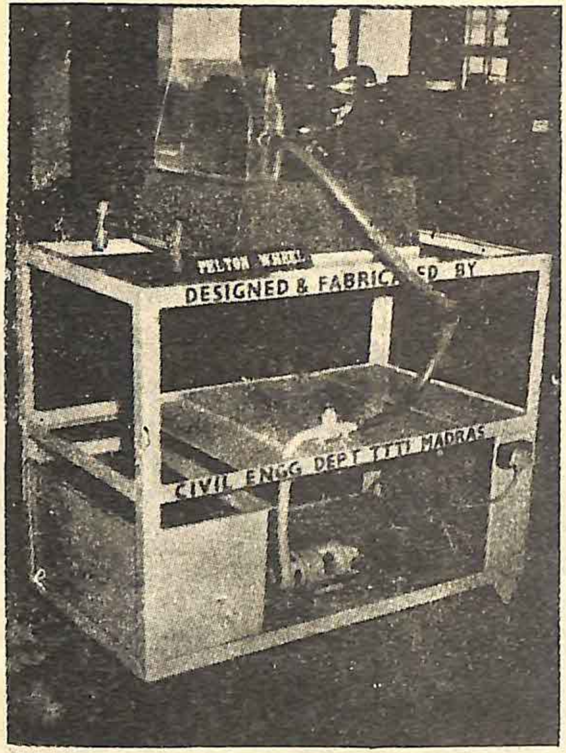


Fig 1

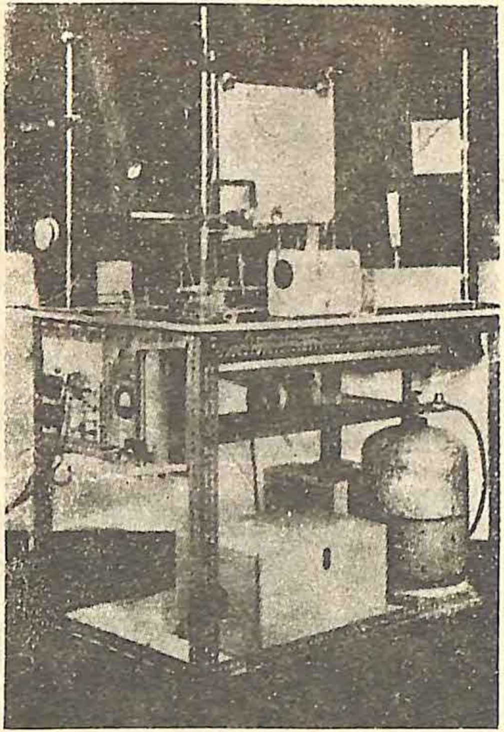
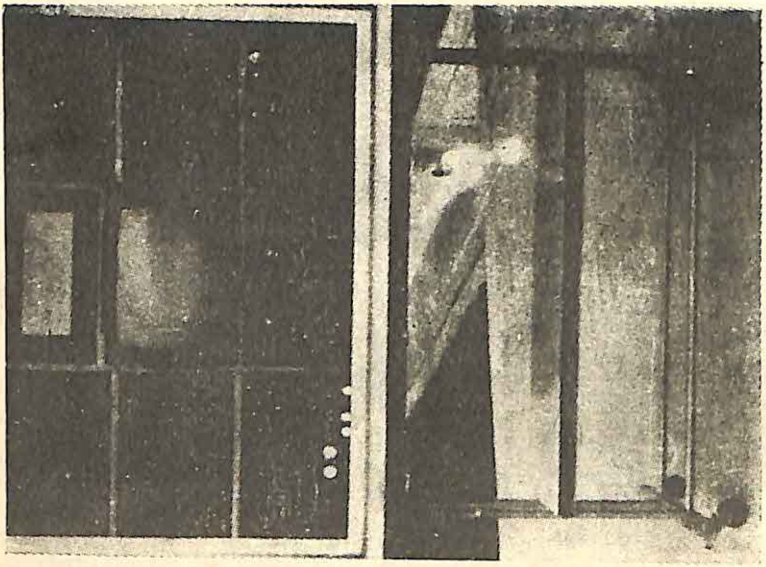


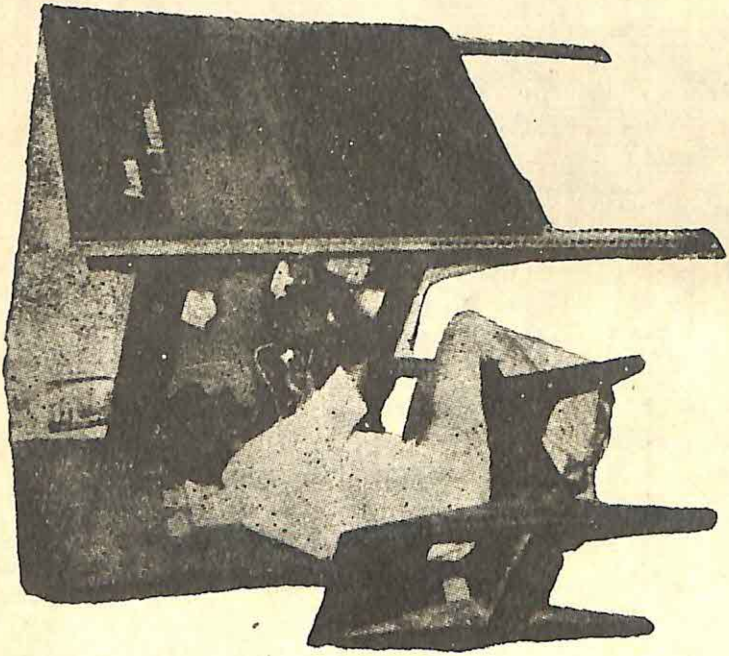
Fig 2

Appendix 2

Fig. 1 Civil Engineering Trolley
Fig. 2 Science Trolley



Appendix 2
Electronics Trolley



Appendix 3
Audio Tutorial Module

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COMPUTERS
for
Beginners

R. Thiagarajan

The birth of electronic computers to help decision makers has truly been acclaimed as the second industrial revolution. While one hears of a computer replacing the human brain, but the intricacies of the human brain are too complex to be replaced by a machine at present. Computers are being used today for a host of applications from routine jobs of billing to sophisticated problems such as control of spaceships. Even domestic computers are available to relieve part of the drudgery of the housewife.

This book is an attempt at explaining the various facets of electronic computers in simple terms. Problem solving has been given more prominence in preference to hardware. Some of the common languages Basic, Cobol, Fortran PL/I, APL, are mentioned and the basics of how a computer programme is compiled.

With the plans of the Government of India to introduce computers in schools, it is hoped, the book would become a 'Computer Primer' textbook. With this in view a number of questions have also been provided at the end of every chapter.

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